SECTION TABLE OF CONTENTS

DIVISION 03 - CONCRETE

SECTION 03100

STRUCTURAL CONCRETE FORMWORK



-- End of Section Table of Contents --

SECTION 03100

STRUCTURAL CONCRETE FORMWORK

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

ACI 347R (1994) Guide to Formwork for Concrete

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA ANSI/AHA A135.4 (1995) Basic Hardboard

DEPARTMENT OF COMMERCE (DOC)

DOC PS 1 (1996) Voluntary Product Standard - Construction and Industrial Plywood

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Manufacturer's Data; FIO.

Submit manufacturer's data, including literature describing form materials, accessories, and form release agents.

Design Analysis and Calculations; FIO.

Submit design analysis and calculations for form design and methodology used in the design.

SD-04 Drawings

Concrete Formwork; GA.

Submit shop drawings for concrete formwork showing details of formwork, including concrete temperature, maximum rate of pour, material allowable stresses for formwork components, joints, supports, studding and shoring, and sequence of form and shoring removal.

## 1.3 DESIGN

Formwork shall be designed in accordance with methodology of ACI 347R for anticipated loads, lateral pressures, and stresses. Forms shall be capable of producing a surface which meets the requirements of the class of finish specified in Section 03300 CONCRETE FOR BUILDING CONSTRUCTION. Forms shall be capable of withstanding the pressures resulting from placement and vibration of concrete.

# PART 2 PRODUCTS

## 2.1 FORM MATERIALS

Class A finish shall include all concrete that is exposed to view. Class C finish shall include concrete that is in contact with earth. Class B finish shall include all concrete that is not defined as Class A or C.

### 2.1.1 Forms For Class A and Class B Finish

Forms for Class A and Class B finished surfaces shall be plywood panels conforming to DOC PS 1, Grade B-B concrete form panels, Class I or II. Other form materials or liners may be used provided the smoothness and appearance of concrete produced will be equivalent to that produced by the plywood concrete form panels. Forms for round columns shall be the prefabricated seamless type.

### 2.1.2 Forms For Class C Finish

Forms for Class C finished surfaces shall be shiplap lumber; plywood conforming to DOC PS 1, Grade B-B concrete form panels, Class I or II; tempered concrete form hardboard conforming to AHA ANSI/AHA A135.4; other approved concrete form material; or steel, except that steel lining on wood sheathing shall not be used. Forms for round columns may have one vertical seam.

### 2.1.3 Retain-In-Place Metal Forms

Retain-in-place metal forms for concrete slabs and roofs shall be as specified in Section 05300 STEEL DECKING.

### 2.1.4 Form Ties

Form ties shall be factory-fabricated metal ties, shall be of the removable or internal disconnecting or snap-off type, and shall be of a design that will not permit form deflection and will not spall concrete upon removal. Solid backing shall be provided for each tie. Except where removable tie rods are used, ties shall not leave holes in the concrete surface less than 1/4 inch nor more than 1 inch deep and not more than 1 inch in diameter. Removable tie rods shall be not more than 1-1/2 inches in diameter.

### 2.1.5 Form Releasing Agents

Form releasing agents shall be commercial formulations that will not bond with, stain or adversely affect concrete surfaces. Agents shall not impair subsequent treatment of concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds.

## PART 3 EXECUTION

### 3.1 FORMWORK

Forms shall be mortar tight, properly aligned and adequately supported to produce concrete surfaces meeting the surface requirements specified in Section 03300 CONCRETE FOR BUILDING CONSTRUCTION and conforming to construction tolerance given in TABLE 1. Where concrete surfaces are to have a Class A or Class B finish, joints in form panels shall be arranged as approved. Where forms for continuous surfaces are placed in successive units, the forms shall fit over the completed surface to obtain accurate alignment of the surface and to prevent leakage of mortar. Forms shall not be reused if there is any evidence of surface wear and tear or defects which would impair the quality of the surface. Surfaces of forms to be reused shall be cleaned of mortar from previous concreting and of all other foreign material before reuse. Form ties that are to be completely withdrawn shall be coated with a nonstaining bond breaker.

### 3.2 CHAMFERING

Except as otherwise shown, external corners that will be exposed shall be chamfered, beveled, or rounded by moldings placed in the forms.

### 3.3 COATING

Forms shall be coated with a form releasing agent before the form or reinforcement is placed in final position. The coating shall be used as recommended in the manufacturer's printed or written instructions. Surplus coating on form surfaces and coating on reinforcing steel and construction joints shall be removed before placing concrete.

### 3.4 REMOVAL OF FORMS

Forms shall be removed preventing injury to the concrete and ensuring the complete safety of the structure. Formwork for columns, walls, side of beams and other parts not supporting the weight of concrete may be removed when the concrete has attained sufficient strength to resist damage from the removal operation but not before at least 24 hours has elapsed since concrete placement. Supporting forms and shores shall not be removed from beams, floors and walls until the structural units are strong enough to carry their own weight and any other construction or natural loads. Supporting forms or shores shall not be removed before the concrete strength has reached 70 percent of design strength, as determined by field cured cylinders or other approved methods. This strength shall be demonstrated by job-cured test specimens, and by a structural analysis considering the proposed loads in relation to these test strengths and the strength of forming and shoring system. The job-cured test specimens for form removal purposes shall be provided in numbers as directed and shall be in addition to those required for concrete quality control. The specimens shall be removed from molds at the age of 24 hours and shall receive, insofar as possible, the same curing and protection as the structures they represent.

TABLE 1

TOLERANCES FOR FORMED SURFACES

| | | |
|---|---|---|
| 1. | Variations from the plumb: | In any 10 feet of length ---------- 1/4 inch |
| | a. In the lines and surfaces of columns, piers, walls and in arises | Maximum for entire length ---------- 1 inch |
| | b. For exposed corner columns,control-joint grooves, and other conspicuous lines | In any 20 feet of length ---------- ---- 1/4 inch<br>Maximum for entire length---------- 1/2 inch |
| 2. | Variation from the level or from the grades indicated on the drawings: | In any 10 feet of length ----------1/4 inch<br>In any bay or in any 20 feet of length---------- 3/8 inch |
| | a. In slab soffits, ceilings, beam soffits, and in arises, measured before removal of supporting shores | Maximum for entire length ---------- 3/4 inch |
| | b. In exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines | In any bay or in any 20 feet of length ---------- ----- 1/4 inch<br>Maximum for entire length---------- 1/2 inch |
| 3. | Variation of the linear building lines from established position in plan | In any 20 feet --------- 1/2 inch<br>Maximum ----------1 inch |
| 4. | Variation of distance between walls, columns, partitions | 1/4 inch per 10 feet of distance, but not more than 1/2 inch in any one bay,and not more than 1 inch total variation |
| 5. | Variation in the sizes and locations of sleeves, floor openings, and wall opening | Minus ---------- 1/4 inch<br>Plus ---------- 1/2 inch |
| 6. | Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls | Minus ---------- 1/4 inch<br>Plus ---------- 1/2 inch |
| 7. | Footings: | |

TABLE 1

TOLERANCES FOR FORMED SURFACES

| | | |
|---|---|---|
| a. | Variation of dimensions in plan | Minus ---------- 1/2 inch<br>Plus ---------- 2 inches when formed or plus 3 inches when placed against unformed excavation |
| b. | Misplacement of eccentricity | 2 percent of the footing width in the direction of misplacement but not more than 2 inches |
| c. | Reduction in thickness of specified thickness | Minus ---------- 5 percent |
| 8. | Variation in steps: | Riser ---------- 1/8 inch |
| a. | In a flight of stairs | Tread ---------- 1/4 inch |
| b. | In consecutive steps | Riser ---------- 1/16 inch<br>Tread ---------- 1/8 inch |

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 03 - CONCRETE

SECTION 03150

EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS



-- End of Section Table of Contents --

SECTION 03150

EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM C 920 | (1998) Elastomeric Joint Sealants |
| ASTM D 1751 | (1997) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types) |
| ASTM D 1752 | (1984; R 1996) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction |
| ASTM D 3405 | (1997) Joint Sealants, Hot-Applied, for Concrete and Asphalt Pavements |
| ASTM D 5249 | (1995) Backer Material for Use With Cold and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints |

CORPS OF ENGINEERS (COE)

| | |
|---|---|
| COE CRD-C 513 | (1974) Corps of Engineers Specifications for Rubber Waterstops |
| COE CRD-C 572 | (1974) Corps of Engineers Specifications for Polyvinylchloride Waterstop |

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Manufacturer's literature; FIO.

Manufacturer's literature, including catalog cuts and safety data sheets if applicable. The literature shall include adequate data to attest that the products conform to the requirements specified.

SD-04 Drawings

Joint Layout; GA.

Shop Drawings showing the proposed layout of joints in the capping slab for the new Central Control Station.

SD-06 Instructions

Installation Instructions; FIO.

Manufacturer's instructions for installing sealants; installing waterstops; and for splicing waterstops.

## 1.3 DELIVERY AND STORAGE

Material delivered and placed in storage shall be stored off the ground and protected from moisture, dirt, and other contaminants. Sealants shall be delivered in the manufacturer's original unopened containers. Sealants whose shelf life has expired shall be removed from the site.

# PART 2 PRODUCTS

## 2.1 EXPANSION JOINT FILLER

Expansion joint filler shall be preformed material conforming to ASTM D 1751 or ASTM D 1752. Unless otherwise indicated, filler material shall be 3/8 inch thick and of a width applicable for the joint formed. Backer material, when required, shall conform to ASTM D 5249.

## 2.2 SEALANT

Joint sealant shall conform to the following:

a. Hot-Poured Type: ASTM D 3405.

b. Cold-Applied Type: Sealant shall be a polyurethane base type conforming to ASTM C 920 Type S (1 component) or Type M (multicomponent), Grade P for horizontal joints, Grade NS for vertical joints, Class 25 and Use T for horizontal joints and Use NT for vertical joints. If recommended by the manufacturer, the joint sealant shall be used with the manufacturer's specified primer.

## 2.3 WATERSTOPS

Waterstops shall conform to COE CRD-C 513 for rubber, or COE CRD-C 572 for polyvinylchloride. Waterstop materials shall be resistant to petroleum products.

# PART 3 EXECUTION

## 3.1 JOINTS

Control Joints in the New Central Control Structure 1st Floor Capping Slab shall be constructed by cutting the concrete with a saw after concrete has set. Joints shall be approximately 1/8 inch wide and shall extend into the

slab approximately one fourth of the slab thickness, but not less than 1 inch. Control joints shall be located at a maximum spacing of 15 feet in both directions.

### 3.1.1 Sawed Joints

Joint sawing shall be early enough to prevent uncontrolled cracking in the slab, but late enough that this can be accomplished without appreciable spalling. Concrete sawing machines shall be adequate in number and power, and with sufficient replacement blades to complete the sawing at the required rate. Joints shall be cut to true alignment and shall be cut in sequence of concrete placement. Sludge and cutting debris shall be removed.

### 3.1.2 Expansion Joints

Preformed expansion joint filler shall be used in expansion and isolation joints in slabs around columns and between slabs on grade and vertical surfaces where indicated. The filler shall extend the full slab depth, unless otherwise indicated. The edges of the joint shall be neatly finished with an edging tool of 1/8 inch radius, except where a resilient floor surface will be applied. Where the joint is to receive a sealant, the filler strips shall be installed at the proper level below the finished floor with a slightly tapered, dressed and oiled wood strip temporarily secured to the top to form a recess 3/4 inch deep to be filled with sealant. The wood strip shall be removed after the concrete has set. Contractor may opt to use a removable expansion filler cap designed and fabricated for this purpose in lieu of the wood strip. The groove shall be thoroughly cleaned of laitance, curing compound, foreign materials, protrusions of hardened concrete, and any dust which shall be blown out of the groove with oil-free compressed air.

### 3.1.3 Joint Sealant

Control joints and expansion joints in slabs shall be filled with joint sealant. Joint surfaces shall be clean, dry, and free of oil or other foreign material which would adversely affect the bond between sealant and concrete. Joint sealant shall be applied as recommended by the manufacturer of the sealant.

## 3.2 WATERSTOP INSTALLATION

Waterstops shall be installed at the locations shown to form a continuous water-tight diaphragm. Adequate provision shall be made to support and completely protect the waterstops during the progress of the work. Any waterstop punctured or damaged shall be repaired or replaced. Exposed waterstops shall be protected during application of form release agents to avoid being coated. Splices shall be made in conformance with the recommendations of the waterstop manufacturer. Continuity of the characteristic features of the cross section of the waterstop (ribs, tabular center axis, protrusions, etc.) shall be maintained across the splice. Splices showing evidence of separation after bending shall be remade.

## 3.3 WATERSTOP SPLICING

### 3.3.1 Rubber Waterstop

Splices shall be vulcanized or shall be made using cold bond adhesive as recommended by the manufacturer. Splices for thermoplastic elastomeric

rubber (TPE-R) waterstops shall be as specified for PVC.

3.3.2 Polyvinyl Chloride Waterstop

Splices shall be made by heat sealing the adjacent waterstop edges together using a thermoplastic splicing iron utilizing a non-stick surface specifically designed for waterstop welding. The correct temperature shall be used to sufficiently melt without charring the plastic. The spliced area, when cooled, shall show no signs of separation, holes, or other imperfections when bent by hand in as sharp an angle as possible.

3.3.3 Quality Assurance

Edge welding will not be permitted. Centerbulbs shall be compressed or closed when welding to non-centerbulb type. Waterstop splicing defects which are unacceptable include, but are not limited to the following: 1) Tensile strength less than 80 percent of parent section. 2) Free lap joints. 3) Misalignment of centerbulb, ribs, and end bulbs greater than 1/16 inch. 4) Misalignment which reduces waterstop cross section more than 15 percent. 5) Bond failure at joint deeper than 1/16 inch or 15 percent of material thickness. 6) Misalignment of waterstop splice resulting in misalignment of waterstop in excess of 1/2 inch in 10 feet. 7) Visible porosity in the weld area, including pin holes. 8) Charred or burnt material. 9) Bubbles or inadequate bonding. 10) Visible signs of splice separation when cooled splice is bent by hand at a sharp angle.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 03 - CONCRETE

SECTION 03200

CONCRETE REINFORCEMENT



-- End of Section Table of Contents --

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

| | |
|---|---|
| ACI 318/318R | (1995) Building Code Requirements for Structural Concrete and Commentary |
| ACI 318M | (1995) Building Code Requirements for Structural Concrete and Commentary (Metric) |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM A 184/A 184M | (1996) Fabricated Deformed Steel Bar Mats for Concrete Reinforcement |
| ASTM A 185 | (1997) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement |
| ASTM A 497 | (1997) Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement |
| ASTM A 615/A 615M | (1996a) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement |
| ASTM A 706/A 706M | (1998) Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement |

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

| | |
|---|---|
| CRSI MSP-1 | (1996) Manual of Standard Practice |

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Concrete Reinforcement System; GA.

Detail drawings showing reinforcing steel placement, schedules, sizes,

grades, and splicing and bending details. Drawings shall show support details including types, sizes and spacing.

SD-13 Certificates

Reinforcing Steel; FIO.

Certified copies of mill reports attesting that the reinforcing steel furnished meets the requirements specified herein. Submit prior to the installation of reinforcing steel.

1.3 DELIVERY AND STORAGE

Reinforcement and accessories shall be stored off the ground on platforms, skids, or other supports.

PART 2 PRODUCTS

2.1 DOWELS

Dowels shall conform to ASTM A 615, Grade 60.

2.2 FABRICATED BAR MATS

Fabricated bar mats shall conform to ASTM A 184/A 184M, Grade 60.

2.3 REINFORCING STEEL

Reinforcing steel shall be deformed bars conforming to ASTM A 615/A 615M or ASTM A 706/A 706M, grade 60 and sizes as indicated.

2.4 WELDED WIRE FABRIC

Welded wire fabric shall conform to ASTM A 185 or ASTM A 497.

2.5 WIRE TIES

Wire ties shall be 16 gauge or heavier black annealed steel wire.

2.6 SUPPORTS

Bar supports for formed surfaces shall be designed and fabricated in accordance with CRSI MSP-1 and shall be steel or precast concrete blocks. Precast concrete blocks shall be not less than 4 inches square when supporting reinforcement on ground. Precast concrete block shall have compressive strength equal to that of the surrounding concrete. Where concrete formed surfaces will be exposed to weather or where surfaces are to be painted, steel supports within 1/2 inch of concrete surface shall be plastic protected or of stainless steel. Concrete supports used in concrete exposed to view shall have the same color and texture as the finish surface. For slabs on grade or topping over insulation, supports shall be precast concrete blocks, plastic coated steel fabricated with bearing plates, or specifically designed wire-fabric supports fabricated of plastic with bearing plates.

PART 3 EXECUTION

## 3.1 REINFORCEMENT

Reinforcement shall be fabricated to shapes and dimensions shown and shall conform to the requirements of ACI 318/318R. Reinforcement shall be cold bent unless otherwise authorized. Bending shall be accomplished at the fabricator's shop. Bars shall not be bent after embedment in concrete. Safety caps shall be placed on all exposed ends of vertical concrete reinforcement bars that pose a danger to life and safety. Wire tie ends shall face away from the forms.

### 3.1.1 Placement

Reinforcement shall be free from loose rust and scale, dirt, oil, or other deleterious coating that could reduce bond with the concrete. Reinforcement shall be placed in accordance with ACI 318/318R at locations shown plus or minus one bar diameter. Reinforcement shall not be continuous through expansion joints and shall be as indicated through construction or contraction joints. Concrete coverage shall be as indicated or as required by ACI 318/318R. If bars are moved more than one bar diameter to avoid interference with other reinforcement, conduits or embedded items, the resulting arrangement of bars, including additional bars required to meet structural requirements, shall be approved before concrete is placed.

### 3.1.2 Splicing

Splices of reinforcement shall conform to ACI 318/318R and shall be made only as required or indicated. Splicing shall be by lapping or by mechanical or welded butt connection; except that lap splices shall not be used for bars larger than No. 11 unless otherwise indicated. Lapped bars shall be placed in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete. Lapped bars shall not be spaced farther apart than one-fifth the required length of lap or 6 inches. Mechanical butt splices shall be in accordance with the recommendation of the manufacturer of the mechanical splicing device. Butt splices shall develop 125 percent of the specified minimum yield tensile strength of the spliced bars or of the smaller bar in transition splices. Bars shall be flame dried before butt splicing. Adequate jigs and clamps or other devices shall be provided to support, align, and hold the longitudinal centerline of the bars to be butt spliced in a straight line.

## 3.2 WELDED-WIRE FABRIC PLACEMENT

Welded-wire fabric shall be placed in slabs as indicated. Fabric placed in slabs on grade shall be continuous between expansion, construction, and contraction joints. Lap splices shall be made in such a way that the overlapped area equals the distance between the outermost crosswires plus 2 inches. Laps shall be staggered to avoid continuous laps in either direction. Fabric shall be wired or clipped together at laps at intervals not to exceed 4 feet. Fabric shall be positioned by the use of supports.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 03 - CONCRETE

SECTION 03230

GUIDEWALL POST TENSIONED BARS



-- End of Section Table of Contents --

SECTION 03230

GUIDEWALL POST TENSIONED BARS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

| | |
|---|---|
| ACI 315 | (1992) ACI Detailing Manual: Section Details and Detailing of Concrete Reinforcement |
| ACI 318/318R | (1995) Building Code Requirements for Structural Concrete and Commentary |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM A 722/A 722M | (1995) Uncoated High-Strength Steel Bar for Prestressing Concrete |

1.2 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Manufacturers Literature; GA.

a. manufacturers literature for the post tensioning bars, including catalog cuts, applications guide, installation instructions, and standard warranty
b. manufacturers literature for the mooring post concrete anchors, including catalog cuts, applications guide, installation instructions, details for corrosion protection (typical, at anchorages, and through monolith joints)
c. manufacturers literature for the load cells and reader, including installation instructions, operations manual, calibration data, temperature corrections, and standard warranty

SD-04 Drawings

Installation Drawings; GA.

Installation drawings for bars and accessories shall be submitted. The drawings shall indicate:

a. concrete removal lines and methods

b. schedule for interruption of service for the mooring posts, handrail, and tow haulage unit
b. details of duct work, including description of tolerance to movement at monolith joints
c. erection methods, sequence of tensioning, and tensioning calculations
d. plan for placement of concrete, including mix design and pour quantities

SD-09 Reports

Tensioning Bars and Accessories; FIO.

Certified materials test reports shall be submitted for all required materials tests, note the specific standards followed in the performance of tests, show that materials comply with the applicable specifications, be submitted for each material shipment and be identified with specific lots prior to use of materials in the work.

SD-18 Records

Post Tensioning Operations Records; FIO.

Complete records of the post tensioning operations shall be submitted.

## 1.3 DELIVERY, STORAGE AND HANDLING OF MATERIALS

Materials shall be suitably wrapped, packaged or covered at the factory to prevent being affected by dirt, water and rust. Materials shall be protected against abrasion or damage during shipment and handling. Materials stored at the site shall be placed above ground on elevated, covered platforms.

## 1.4 SUPERVISION

The bars shall be installed (including the corrosion protection system) and tensioned by, or under the supervision of, the bar supplier. The Government will observe the tensioning and monitor monolith joint movement during the tensioning process. The tensioning loads may be modified by the Government during the tensioning process based on observed monolith deflections.

# PART 2 PRODUCTS

## 2.1 BAR MATERIALS

Tensioning bars and accessories shall conform to the requirements of ACI 318/318R except as specified.

### 2.1.1 Post Tensioning Bars

Post tensioning bars shall be high strength steel conforming to ASTM A 722/A 722M, Type I or II, meeting all supplementary requirements. The bars shall be unbonded through the entire length, and installed in post tensioning ducts. The bars shall be installed with a double corrosion protection system designed for permanent use in an aggressive environment. Acceptable corrosion protection systems include epoxy coating, grease, wax, coal tar, grout, or other approved system. Sheaths, conduits, and ducts

that do not provide a tight fit and a barrier to vapor transmission are considered incidental to the corrosion protection system. Grout shall be proportioned for a minumum 8000 psi compressive strength, if used. Grout, wax, tar, and viscous coatings shall be contained within a sheath or duct to keep the bar unbonded, including dynamic loads with the potential of compressing the end monolith joint 2 inches (or to a tight contact, which ever is less). Tensioning bars shall be clean and free of loose rust, scale and pitting.

2.1.2 Ducts

The bars shall be capable of accomodating a 1 inch lateral movement in either direction (north-east or south-west, tranverse to the wall) at the monolith joints under dynamic loading. The inside diameter of the ducts shall be large enough to provide an annulus around the bar to accomodate this movement without shearing or damaging the bars. The bars shall be centralized in the ducts during installation, with particular attention near the monolith joints. Ducts shall be designed for watertight connections with all fittings. Galvanized ducts will not be permitted.

2.1.3 Anchorages and Couplers

Anchorages and couplers shall be metal of proven corrosion resistance and compatible with the tensioning bars, capable of fully developing the minimum guaranteed ultimate strength of bars without excessive slip and approved. Anchorages shall be the button-head, wedge, nut and thread, grip nut, thread-bar, threaded plate or other approved type and shall be provided with bearing plates, rings, bells or other positive-attaching anchor fittings. Couplers shall be provided with housings long enough to permit the necessary movements and fittings which allow complete grouting of all components.

2.2 LOAD CELLS

Four electronic load cells and a compatible meter with built-in excitation to read the load cells shall be provided. The meter shall have the capability to display in engineering units. The load cells shall have a nominal capacity of 50 kips, an accuracy within 1.0% (including errors introduced by the excitation and readout system), a resolution of at least $\pm$ 100 pounds, and an operating temperature range to -40F. The load cells shall be designed for exterior use, water proof, weather proof, and shall include insulated, shielded cables that can be easily accessed for future monitoring by the Government. The electronic load cells shall be permanently installed at the live end anchorages on bars selected by the Contracting Officer. The meter with the load cells shall be furnished and operating prior to tensioning the bars.

PART 3 EXECUTION

3.1 INSTALLATION

Tensioning bars and accessories shall be installed or placed as specified and as shown on contract and approved installation drawings. Installation details of tensioning bars and accessories not specified or shown shall be in accordance with ACI 315 or ACI 318/318R. Welding shall not be performed near or adjacent to tensioning bars. Tensioning bars shall not be installed until all welding has been completed on supports or any part which might be in contact with the bars.

### 3.1.1 Anchorages

Anchorages must be set in a plane normal to the axis of the bars such that uniform bearing on the concrete is assured. Positive connecting anchorages rather than gripping types shall be used for anchoring embedded ends of bars. Anchorages and anchor fittings shall be permanently protected against corrosion. Parallel wire anchorage wedges or cores shall be recessed within the members.

### 3.1.2 Installing bars and Ducts

Protective coverings and wrappings shall be removed and each tensioning bar shall be closely inspected to see that nicks, scoring, pits or other damage does not exist and high strength steel bars shall be closely inspected to assure that they are not bent and that threaded ends are in satisfactory condition immediately prior to installation. Tensioning bars and ducts shall be assembled to required shapes and dimensions and placed where indicated on drawings within specified tolerances and adequately supported. Ducts shall be securely fastened to either the forms or reinforcing steel to prevent displacement during concrete placing. The ends of ducts shall be effectively protected to prevent entry of water, concrete, grout or debris.

### 3.1.3 Tensioning Bars

Tensioning of bars shall be completed by at least 4 load steps at approximately 10%, 30%, 60% and 100% of the design loads. For each load step, the longest bars shall be tensioned first, proceeding successively to the shortest bars. A waiting period of 1 hour shall be included between each load step to allow time for monitoring of the monolith joint deflections. Initially, only the 4 long bars in each wall shall be tensioned. The 2 short bars in each wall shall be installed loose, unless tensioning is directed by the Government.

Tensioning shall not be performed until concrete cylinder tests indicate a breaking strength of at least 3000 psi. The tension induced in the bars by any method of tensioning shall be determined by direct measurement of force using a pressure gauge or load cell. The force corresponding to the initial tension shall be measured by a dynamometer or other approved method as a starting point in determining final elongation. Safety measures shall be taken by the Contractor to prevent accidental injury caused by failure of a tensioning bar or bar component. The exposed ends of tensioning bars and anchorages shall be protected from damage during tensioning operations to prevent failure.

### 3.1.4 Grouting Post-Tensioned Bars

Grouting shall be completed if required as part of the corrosion protection system in accordance with the manufacturer's recommendations.

### 3.1.5 Stress and Elongation Measurement

Hydraulic gauges, dynamometers, load cells or other devices for measuring tensioning load shall have an accuracy of reading within two percent for stress measurement. The elongation shall be recorded and reported, along with measured changes in the monolith joint gaps. The elongation shall be measured to the nearest 1/16-inch.

### 3.1.6 Post Tensioning Operations Records

The Contractor shall compile and submit complete post tensioning operations records to the Contracting Officer. These records shall show the manufacturer, identification and description of materials and equipment including post tensioning bars and jacking and load measuring equipment; location of post tensioning bars; initial design tensioning loads, final design tensioning loads and actual tensioning loads for bars; dates tensioning loads applied; and theoretical and actual elongations for bars.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 03 - CONCRETE

SECTION 03300

CONCRETE FOR BUILDING CONSTRUCTION

-- End of Section Table of Contents --

SECTION 03300

CONCRETE FOR BUILDING CONSTRUCTION

PART 1 GENERAL

This section covers cast-in-place concrete, including concrete required for electrical equipment mounting pads and foundations, maintenance building slab, concrete apron, concrete required for embedment of conduit and topping concrete for use in concrete pan stairs, CCS floor slab topping, slab closure at the existing control station and control stands, tank foundation pads, horizontal repairs and light standard repairs on the lock monoliths. Also included under this section is the sandwiched slab insulation.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

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| ACI 117/117R | (1990; Errata) Standard Tolerances for Concrete Construction and Materials |
| ACI 211.1 | (1991) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete |
| ACI 214.3R | (1988) Simplified Version of the Recommended Practice for Evaluation of Strength Test Results |
| ACI 301 | (1996) Standard Specifications for Structural Concrete |
| ACI 305R | (1991) Hot Weather Concreting |
| ACI 306R | (1988) Cold Weather Concreting |
| ACI 309R | (1996) Consolidation of Concrete |

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

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|---|---|
| AASHTO M 182 | (1991) Burlap Cloth Made From Jute or Kenaf |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

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| ASTM C 31 | (1998) Making and Curing Concrete Test Specimens in the Field |
| ASTM C 33 | (1997) Concrete Aggregates |
| ASTM C 39 | (1994) Compressive Strength of Cylindrical Concrete Specimens |
| ASTM C 94 | (1996) Ready-Mixed Concrete |
| ASTM C 136 | (1995a) Sieve Analysis of Fine and Coarse Aggregates |
| ASTM C 143 | (1990a) Slump of Hydraulic Cement Concrete |
| ASTM C 150 | (1995) Portland Cement |
| ASTM C 171 | (1995) Sheet Materials for Curing Concrete |
| ASTM C 172 | (1990) Sampling Freshly Mixed Concrete |
| ASTM C 192 | (1990a) Making and Curing Concrete Test Specimens in the Laboratory |
| ASTM C 231 | (1991b) Air Content of Freshly Mixed Concrete by the Pressure Method |
| ASTM C 260 | (1995) Air-Entraining Admixtures for Concrete |
| ASTM C 309 | (1995) Liquid Membrane-Forming Compounds for Curing Concrete |
| ASTM C 494 | (1992) Chemical Admixtures for Concrete |
| ASTM C 578 | (1995) Preformed, Cellular Polystyrene Thermal Insulation |
| ASTM C 591 | (1994) Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation |
| ASTM C 595 | (1995a) Blended Hydraulic Cements |
| ASTM C 618 | (1996a) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete |
| ASTM C 685 | (1995) Concrete Made by Volumetric Batching and Continuous Mixing |
| ASTM C 881 | (1990) Epoxy-Resin-Base Bonding Systems for Concrete |

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| ASTM C 989 | (1994a) Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars |
| ASTM C 1064 | (1986; R 1993) Temperature of Freshly Mixed Portland Cement Concrete |
| ASTM C 1077 | (1995a) Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation |
| ASTM D 75 | (1987; R 1992) Sampling Aggregates |
| ASTM D 1751 | (1983; R 1991) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types) |
| ASTM D 1752 | (1984; R 1992) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction |
| ASTM E 96 | (1995) Water Vapor Transmission of Materials |

CORPS OF ENGINEERS (COE)

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|---|---|
| COE CRD-C 400 | (1963) Requirements for Water for Use in Mixing or Curing Concrete |

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

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| NIST HB 44 | (1995) NIST Handbook 44: Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices |

NATIONAL READY-MIXED CONCRETE ASSOCIATION (NRMCA)

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|---|---|
| NRMCA TMMB-01 | (1992) Truck Mixer Agitator and Front Discharge Concrete Carrier Standards of the Truck Mixer Manufacturers Bureau |
| NRMCA CPMB 100 | (1990) Concrete Plant Standards |
| NRMCA QC 3 | (1984) Quality Control Manual: Section 3, Plant Certifications Checklist: Certification of Ready Mixed Concrete Production Facilities |

WISCONSIN DEPARTMENT OF TRANSPORTATION (WIDOT), Standard Specifications for Construction

| | |
|---|---|
| WIDOT 502 | (1996) Concrete Bridges |

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Shop Drawings; GA.

Shop drawings shall be submitted on a continuing basis during the life of the contract. The drawings shall be shown at not less than 1/4 inch equals 1 foot scale. The drawings shall show accurate concrete outlines and all types of joints. A numbering system shall be established to facilitate ready identification of each lift. The drawing shall cover in detail the design, construction, adjustment, and maintenance of the formwork and shall indicate all major design values of form materials to be used and the loading conditions on the form, including rate of concrete placement. Approval will not relieve the Contractor of responsibility of accuracy of the drawings or for the inclusion of all embedded items or other requirements specified herein.

SD-08 Statements

Concrete Mixture Design; GA.

A mix design shall be submitted for each concrete mix to be used on the project. Each mix design shall list the proportions by weight of cement, weight or volume of water, weights of aggregates in a saturated surface-dry condition, and type, quantity, and name of admixtures per cubic yard of concrete. All materials included in the mixture shall be of the same type and from the same source as will be used on the project. Each mix shall be accompanied by evidence by one of the following methods that demonstrates the mix will produce concrete having the characteristics and quality as specified:

a. Project Data. Submit evidence obtained within the last 5 years from previous quality control testing on the concrete mix.

b. Mix Design Study. Submit a mix design study complying with ACI 211.1 conducted in the past 12 months. The mix design shall be completed by a testing laboratory complying with ASTM C 1077.

Project data or mix design studies shall be obtained for the exact mix as submitted. Minor mix alterations or substitutions may be accepted if approved by the Contracting Officer. Any alternations or substitutions shall be clearly indentified, and shall be accompanied by recommendations from the admixture supplier or a registered professional engineer indicating the expected effects on the concrete.

Concrete Operation Plan; GA.

The plan shall demonstrate a thorough understanding of all involved technical and logistical conditions necessary for the production of concrete that meets all requirements of these specifications. The plan shall provide as a minimum the following:

a. Sources of cement, pozzolan, and aggregates.
b. Location of aggregate stockpiles, batching plant, and mixing plant.
c. Method and route for conveying batched concrete under all expected weather conditions.
d. Method of conveying concrete within the project.
e. Sources of electrical power and water.
f. Provisions for replacement of required equipment in the event of breakdown.
g. Methods for preventing aggregate stockpiles from freezing, moisture variation, or contamination.
h. Methods of consolidation and curing. Include manufacturer's literature.
i. Contractor quality control.
j. Provisions for maintaining a working access or platform for lock personnel engaged in lock operations during placement and curing of concrete for horizontal repairs.

Cold Weather Plan; GA.

If concrete is to be placed under cold weather conditions, the procedures, materials, methods, and protection proposed to accomplish it shall be submitted for review.

Hot Weather Plan; GA.

If concrete is to be placed under hot weather conditions, the procedures, materials, methods, and protection proposed to accomplish it shall be submitted for review.

Joint Treatment Plan; FIO..

The methods and equipment proposed for joint cleanup and waste disposal shall be submitted for review.

SD-13 Certificates

Manufacturer's Certificates; FIO.

The following materials shall be certified for compliance with all specification requirements:

a. Cement and pozzolan
b. Impervious sheet curing materials
c. Admixtures
d. Curing compound

Qualifications; FIO.

Written documentation for Contractor Quality Control personnel.

Batch Tickets.

Batch tickets shall be collected and furnished to the Contracting Officer for each load of ready-mixed concrete. The batch tickets do not need to be transmited through the submittal process.

## 1.3 QUALIFICATIONS

Contractor Quality Control personnel assigned to concrete construction shall be American Concrete Institute (ACI) Certified Workmen in grade I or higher or shall have written evidence of having completed similar qualification programs:

## 1.4 CONSTRUCTION TOLERANCES

Variation in alignment, grade, and dimensions of the structures from the established alignment, grade, and dimensions shown shall be within the tolerances specified in SECTION 03100 - CONCRETE FORMWORK.

### 1.5.1 Appearance

Abrupt variations in color, shade, or tint will not be permitted on exposed surfaces. Use of pozzolan shall be controlled to limit discoloration. Finished surfaces shall be protected from stains or abrasions. Permanently exposed surfaces shall be cleaned, if stained or otherwise discolored, by an approved method that does not harm the concrete.

## 1.5 STORAGE OF MATERIALS

Cement and other cementitious materials shall be stored in weathertight buildings, bins, or silos which will exclude moisture and contaminants and keep each material completely separated. Aggregate stockpiles shall be arranged and used in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of aggregates. Aggregate shall not be stored directly on ground unless a sacrificial layer is left undisturbed. Reinforcing bars and accessories shall not be stored on cohesive soils or areas that may puddle water. Other materials shall be stored in such a manner as to avoid contamination and deterioration. Admixtures which have been in storage at the project site for longer than 6 months or which have been subjected to freezing shall not be used unless retested and proven to meet the specified requirements. Materials shall be capable of being accurately identified after bundles or containers are opened.

## 1.6 GOVERNMENT ASSURANCE INSPECTION AND TESTING

The Contracting Officer may appoint a Government representative or an independent testing laboratory to inspect construction and monitor operations of the Contractor's CQC staff as considered appropriate for quality assurance. The Contractor shall provide facilities and labor as may be necessary for procurement of representative test samples. Government inspection or testing will not relieve the Contractor of any of

it's CQC responsibilities. Failure to detect defective work or material will not prevent rejection later when a defect is discovered nor will it obligate the Government for final acceptance.

## PART 2 PRODUCTS

### 2.1 GENERAL CONCRETE REQUIREMENTS

Concrete shall be composed of a cementitious material, water, fine and coarse aggregates, and admixtures. The design compressive strength shall not be less than 4,500 pounds per square inch. Water-cement ratio shall not exceed 0.45. Materials shall meet the requirements of the respective publications and other data specified below.

#### 2.1.1 Concrete for Horizontal Repairs

Design compressive strength shall be 3,500 psi in 28 calendar days. Maximum water cement ratio (w/c) shall be 0.40. Concrete for horizontal repairs may, at the Contractor's option, contain a high range water reducing admixture (superplasticizer).

#### 2.1.2 Strength Requirements

The strength of the concrete will be considered satisfactory so long as the average of all sets of three consecutive test results equals or exceeds the specified compressive strength f'c and no individual test result falls below the specified strength f'c by more than 500 psi. A "test" is defined as the average of two companion cylinders, or if only one cylinder is tested, the results of the single cylinder test. Design compressive strength (f'c) shall be evaluated for acceptance at 28 days unless pozzolan is used, in which case the design strength shall be met in 90 calendar days, provided the 90-day period does not extend past the contract expiration date. Members identified with concrete not meeting the criteria shall be replaced. The Contractor may conduct additional testing to verify strength or further define the limits of inferior concrete if approved by the Contracting Officer.

#### 2.1.3 Slump

Slump of the concrete, as delivered to the point of placement into the forms, shall not exceed 4 inches. If a superplastizer is used, the slump shall not exceed 4 inches before the admixture is added and shall not exceed 8 inches at the point of delivery after the admixture is added.

#### 2.1.4 Admixtures

Concrete shall not contain admixtures that provide special properties to the concrete unless specified or approved. Admixtures be used on the project shall be included in the mix design submittals. Accelerating admixtures shall be used only during cold weather and when approved in writing.

##### 2.1.4.1 Air Entrainment

All concrete, except interior concrete in the new central control station to receive a hard steel towel finish, shall be air entrained to contain between 4-1/2 and 7-1/2 percent total air.

2.1.5 Size of Coarse Aggregate

Except as specified for special applications, the nominal maximum size coarse aggregate shall be 1-1/2 inches, except 3/4 inch nominal maximum size coarse aggregate shall be used when any of the following conditions exist: the narrowest dimension between sides of forms is less than 7-1/2 inches, the depth of the slab is less than 4-1/2 inches, or the minimum cover or clear spacing between reinforcing is less than 2 inches.

a. Topping Concrete. Nominal maximum size of coarse aggregate shall be 3/8 inch. Topping concrete shall be used for the 3 inch slabs shown on the drawings and the stair pans.

b. Concrete for Horizontal Repairs. Coarse aggregate shall conform to ASTM C 33, size No. 57 or 67, Class 4S.

2.1.6 Temperature

Concrete for Horizontal Repairs: the maximum concrete temperature at time of placement shall not exceed 85 degrees Fahrenheit.

2.2 CEMENTITIOUS MATERIALS

Cementitious materials shall be portland cement, or portland cement in combination with pozzolan or ground granulated blast furnace slag. Optional pozzolan replacement of cement shall be limited to 20 percent of the total cementitious material of a mix by weight. Cementitious materials shall conform to appropriate specifications listed below. Use of cementitious materials in concrete which will have surfaces exposed in the completed structure shall be restricted so there is no change in color, source, or type of cementitious material.

2.2.1 Portland Cement

ASTM C 150, Type I with a maximum 15 percent amount of tricalcium aluminate, or Type II. White portland cement shall meet the above requirements except that it may be Type I, Type II or Type III. White Type III shall be used only in specific areas of the structure, when approved in writing.

2.2.2 Pozzolan (Fly Ash)

ASTM C 618, Class C or F with the optional requirements for multiple factor, drying shrinkage, and uniformity from Table 2A of ASTM C 618. Requirement for maximum alkalies from Table 1A of ASTM C 618 shall apply.

2.2.3 Ground Granulated Blast-Furnace (GGBF) Slag

ASTM C 989, Grade 120.

## 2.3 AGGREGATES

### 2.3.1 Composition

Fine aggregate shall consist of natural sand, manufactured sand, or a combination of natural and manufactured sands. Coarse aggregate shall consist of gravel, crushed gravel, crushed stone, or a combination thereof.

### 2.3.2 Quality

The aggregate particles shall be clean, hard, unweathered, and uncoated. The shape of the particles shall be generally cubical or spherical. Where required, fines shall be removed from the aggregates by adequate washing. The aggregates as delivered to the mixer shall meet the quality requirements of ASTM C-33, table 3 for the appropriate type or location of concrete construction for use in a severe climate.

### 2.3.3 Sources

Unless approved otherwise, aggregates shall be produced from the sources listed in SECTION 00830 - ATTACHMENTS. If the Contractor proposes to furnish aggregates from a source not listed, the Government will make such tests and other investigations as necessary to determine whether or not aggregates meeting the requirements of this project can be produced from the proposed source. The tests to which the aggregate will be subjected may include specific gravity, absorption, Los Angeles abrasion, soundness in magnesium sulfate, petrographic analysis, freezing and thawing in concrete, alkali-aggregate reaction, organic impurities, deleterious materials, and other tests necessary to determine that concrete of acceptable quality and cost can be produced from the materials proposed. These tests will be conducted in accordance with the applicable Corps of Engineers methods of testing given in the Handbook for Concrete and Cement. When the Contractor desires to use aggregates from a source not listed, suitable samples for quality evaluation consisting of not less than 700 pounds of each size of coarse aggregate and 300 pounds of fine aggregates shall be taken in accordance with ASTM D 75 and delivered to the Contracting Officer or to a laboratory as directed. A maximum of 120 calendar days will be required to complete evaluation of the aggregate.

## 2.4 CHEMICAL ADMIXTURES

Chemical admixtures, when required or permitted, shall conform to the appropriate specification listed.

a. Air-Entraining Admixture. ASTM C 260 and shall consistently entrain the air content in the specified ranges under field conditions.

b. Accelerating Admixture. ASTM C 494, Type C or E, except that calcium chloride or admixtures containing calcium chloride shall not be used.

c. Water-Reducing or Retarding Admixture. ASTM C 494, Type A, B, or D.

d. High-Range Water Reducer. ASTM C 494, Type F or G.

## 2.5 CURING MATERIALS

### 2.5.1 Impervious-Sheet

Impervious-sheet materials shall conform to ASTM C 171, type optional, except that polyethylene sheet shall be white opaque.

### 2.5.2 Membrane-Forming Compound

Membrane-Forming curing compound shall conform to ASTM C 309, Type 1-D or 2, except that only a styrene acrylate or chlorinated rubber compound meeting Class B requirements shall be used for surfaces that are to be painted or are to receive bituminous roofing, or waterproofing, or floors that are to receive adhesive applications of resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing, or flooring specified. Nonpigmented compound shall contain a fugitive dye, and shall have the reflective requirements in ASTM C 309 waived. Membrane-forming curing compound shall not be used on surfaces that are to be treated with floor hardener.

### 2.5.3 Burlap and Cotton Mat

Burlap and cotton mat used for curing shall conform to AASHTO M 182.

## 2.6 WATER

Water for mixing and curing shall be fresh, clean, potable, and free of injurious amounts of oil, acid, salt, or alkali, except that non-potable water may be used if it meets the requirements of COE CRD-C 400. Water for curing shall not contain any substance that stains the concrete. River water shall not be used.

## 2.7 FLOOR HARDENER

Floor hardener shall be a colorless aqueous solution containing either zinc silicofluoride(fluosilicates), magnesium silicofluoride, or sodium silicate. Proprietary hardeners may be used if approved in writing by the Contracting Officer.

## 2.8 FLOOR SEALER

Floor sealer shall be a low viscosity, colorless solution containing not less than 15 percent active ingredients, which will chemically form a hydrophobic barrier resistant to road salts, and oil and gasoline spills, or an acrylic polymer clear film-forming sealer.

## 2.9 JOINT MATERIALS

### 2.9.1 Contraction Joints in Slabs

Waterstops and joint materials shall be as specified in SECTION 03150 - EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS.

2.10 INSULATION

Insulation sandwiched between concrete slabs, shall be polystyrene in conformance with ASTM C 578 Type V or VI.

Insulation sandwiched between concrete slabs that occurs under Rooms 116 and 117 shall be polystyrene in conformance with ASTM C 578 Type V.

2.11 EPOXY ADHESIVE

Shall be a two-component epoxy bonding agent recommended by the manufacturer for bonding dowels and rebar into concrete. The product shall be stable for application at the temperature range expected during construction. Epoxy adhesives shall meet the requirements of ASTM C 881 for the type application as follows:

Dowels in drilled holes:

Horizontal surfaces: Type I, Grade 1, 2 or 3
Vertical surfaces: Type I, Grade 3

Class shall be based on the temperature of the concrete to which the bonding system is to be applied at the time of application.

PART 3 EXECUTION

3.1 CONCRETE FINISH SCHEDULE

a. Broomed Finish. A broomed finish shall be applied to the following surfaces: walks, exterior stairs, surfaces to receive terrazzo, treads of concrete pan stairs, and exterior slab closure.

b. Float Finish. Surfaces to be float-finished shall include the top of the structural slab where insulation is to be applied and all remaining surfaces not specified elsewhere. The finished surface shall be a true plane within 5/16 inch in 10 feet.

c. Trowel Finish. A steel trowel finish shall be applied to all floor surfaces, unless otherwise specified or indicated.

d. Forms. Surfaces, unless another type of finish is specified, shall be left with the texture imparted by the forms, except defective surfaces shall be repaired as described above. Forms shall not be reused if there is any evidence of surface wear or defects that would impair the quality of the surface.

e. Sack Rubbed Finish. Exterior surfaces of cast in place concrete exposed to view on the Central Control Station and the Downstream Control Stand shall receive a sack rubbed finish in accordance with WIDOT 502.3.8.5.

f. Horizontal Concrete Repairs. Concrete shall be screeded,

floated, and lightly troweled to a finish approved by the Contracting Officer. The finished surface shall be a true plane within 5/16 inch in 10 feet.

g. Slabs. Exterior surfaces shall be sloped for drainage, unless otherwise shown.

## 3.2 PREPARATION FOR PLACING

Surfaces to receive concrete shall be clean, damp and free from frost, ice, mud, loose particles, foriegn matter, and water. Forms shall be in place, cleaned, coated, and adequately supported. Reinforcing steel shall be in place, cleaned, tied, and adequately supported. Transporting and conveying equipment shall be in-place, ready for use, clean, and free of hardened concrete and foreign material. Equipment for consolidating concrete shall be at the placing site and in proper working order. Equipment and material for curing and for protecting concrete from weather or mechanical damage shall be at the placing site, in proper working condition and in sufficient amount for the entire placement. Concrete shall not be placed before the completion of all adjacent pile driving or other operations that might prove detrimental to freshly placed concrete.

### 3.2.1 Soil Subgrades

Immediately prior to setting forms and reinforcement, the foundation shall be compacted with a manual tamper.

### 3.2.2 Embedded Items

Before placement of concrete, care shall be taken to determine that all embedded items are firmly and securely fastened in place as indicated on the drawings, or required. Conduit and other embedded items shall be clean and free of oil and other foreign matter such as loose coatings or rust, paint, and scale. The embedding of wood in concrete will be permitted only when specifically authorized or directed. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable materials to prevent the entry of concrete into voids.

### 3.2.3 Concrete for Horizontal Repairs

The existing concrete surface against which the new concrete is to be cast shall be kept continuously wet with potable water for not less than 12 hours immediately prior to concrete placement. Free water shall be removed prior to placement of concrete.

## 3.3 CONCRETE PRODUCTION

Concrete shall be furnished from a ready-mixed concrete plant, except that small batches for pours less than 2 cubic yards may be batched on-site. Ready-mixed concrete shall be batched, mixed, and transported in accordance with ASTM C 94. Truck mixers, agitators, and nonagitating transporting units shall comply with NRMCA TMMB-01. Ready-mix plant equipment and facilities shall be certified in accordance with NRMCA QC 3. Aluminum pipes, chutes, troughs, spouts, or tremies shall not be used for pumping,

conveying, or placing concrete.

### 3.3.1 Concrete Mixers

The mixers shall not be charged in excess of the capacity recommended by the manufacturer. Truck mixers, the mixing of concrete therein, and concrete uniformity shall conform to the requirements of ASTM C 94. Each truck shall be equipped with two counters from which it is possible to determine the number of revolutions at mixing speed and the number of revolutions at agitating speed.

### 3.3.2 Site Mixed Concrete

If the Contractor elects to provide an onsite batching and mixing plant, a batch type plant shall be provided of sufficient capacity to prevent cold joints. Site-mixed concrete shall be produced in conformance with ACI 301, or by volumetric batching and continuous mixing in conformance with ASTM C 685.

## 3.4 TRANSPORTING CONCRETE TO PROJECT SITE

Concrete shall be transported to the placing site in truck mixers conforming to NRMCA TMMB-01.

## 3.5 CONVEYING CONCRETE ON SITE

Concrete shall be conveyed from mixer to forms by methods that will prevent segregation or loss of ingredients. Any concrete transferred from one conveying device to another shall be passed through a hopper, which is conical in shape, and shall not be dropped vertically more than 5 feet, except where suitable equipment is provided to prevent segregation and where specifically authorized. Trucks shall be equipped with radios or phones to permit communication between the mixing plant and the concrete placement site.

### 3.5.1 Concrete Pumps

The pipeline shall be rigid steel pipe or heavy-duty flexible hose. The inside diameter of the pipe shall be at least three times the nominal maximum size coarse aggregate in the concrete mixture to be pumped, but not less than 5 inches. The maximum size coarse aggregate will not be reduced to accommodate the pumps. The distance to be pumped shall not exceed limits recommended by the pump manufacturer. The concrete shall be supplied to the concrete pump continuously. When pumping is completed, concrete remaining in the pipeline shall be ejected without contamination of concrete in place. After each operation, equipment shall be thoroughly cleaned, and flushing water shall be wasted outside of the forms and in compliance with the approved environment protection plan.

## 3.6 PLACING CONCRETE

Mixed concrete shall be discharged within 1-1/2 hours or before the mixer drum has revolved 300 revolutions, whichever comes first after the introduction of the mixing water to the cement and aggregates. When the

length of haul makes it impossible to deliver truck- mixed concrete within this time limit, batching of cement and a portion of the mixing water shall be delayed until the truck mixer is at or near the construction site. Concrete shall be placed within 15 minutes after it has been discharged from the transporting unit. Sufficient placing capacity shall be provided so that concrete can be kept free of cold joints.

### 3.6.1 Depositing Concrete

Concrete shall be deposited as close as possible to its final position in the forms, and there shall be no vertical drop greater than 5 feet except where suitable equipment is provided to prevent segregation and where specifically authorized. Depositing of the concrete shall be so regulated that it will be effectively consolidated in horizontal layers not more than 18 inches thick, except that all slabs shall be placed in a single layer. Concrete to receive other construction shall be screeded to the proper level. Concrete shall be deposited continuously so that fresh concrete is deposited on in-place concrete that is still plastic.

### 3.6.2 Consolidation

Consolidation of concrete shall conform to ACI 309, except as otherwise specified. Immediately after placing, each layer of concrete shall be consolidated by internal vibrators, except for slabs 4 inches thick or less. The vibrators shall at all times be adequate in effectiveness and number to properly consolidate the concrete. A spare vibrator shall be kept at the jobsite during all concrete placing operations. Vibrators shall be inserted vertically at uniform spacing over the area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator so that the area being vibrated will overlap the adjacent just-vibrated area by a reasonable amount. The vibrator shall penetrate rapidly to the bottom of the layer and at least 6 inches into the preceding layer if there is such. Vibrator shall be held stationary until the concrete is consolidated and then vertically withdrawn slowly while operating. Form vibrators shall not be used unless specifically approved and unless forms are constructed to withstand their use. Vibrators shall not be used to move concrete within the forms. Excessive vibration of concrete resulting in segration shall be prevented.

### 3.6.3 Cold Weather Requirements

Concrete shall not be placed without a procedure approved in accordance with paragraph: SUBMITTALS when the concrete is likely to be subjected to freezing temperatures before the expiration of the curing period. Heating of the mixing water or aggregates will be required to regulate the concrete-placing temperatures. The placing temperature of the concrete shall be as recommended in ACI 306R, Table 3.1, with the temperature of the concrete measured in accordance with ASTM C 1064. Air and form temperature in contact with concrete shall be above 50 degrees F prior to placing concrete and maintained for the first 3 days, and at a temperature above 32 degrees F for the remainder of the specified curing period. Thermometers shall be installed at such locations as may be directed. Suitable thermometers shall be furnished by the Contractor and installed adjacent to the concrete surface and 2 inches inside the surface of the

concrete. During the period of protection removal, heat shall be shut down and insulation or tents shall removed in a systematic shedule such that the temperature differential between the air and concrete surface does not exceed 25 degrees F. Exhaust fumes from combustion heating units shall be vented to the outside of the enclosure, and heaters and ducts shall be placed and directed so as not to cause areas of overheating and drying of concrete surfaces or to create fire hazards. Materials entering the mixer shall be free from ice, snow, or frozen lumps.

### 3.6.4 Hot Weather Requirements

Concrete shall be properly placed and finished with approved procedures in accordance with paragraph: SUBMITTALS. When hot, windy conditions during concreting appear probable, equipment and material shall be at the placing site to provide windbreaks, shading, fogging, or other action to prevent plastic shrinkage cracking or other damaging drying of the concrete. The concrete-placing temperature shall not exceed 85 degrees F. Cooling of the mixing water or aggregates or placing concrete in the cooler part of the day may be required to obtain an adequate placing temperature. Steel forms and reinforcements shall be cooled prior to concrete placement when steel temperatures are greater than 120 degrees F. Conveying and placing equipment shall be cooled if necessary to maintain proper concrete-placing temperature. When the rate of evaporation of surface moisture, as determined by use of Figure 2.1.5 of ACI 305, may reasonably be expected to exceed 0.2 pounds per square feet per hour, provision for windbreaks, shading, fog spraying, applying a monomolecular film evaporation reducer, or wet covering with a light-colored material shall be made in advance of placement, and such protective measures shall be taken as quickly as finishing operations will allow.

## 3.7 JOINTS

All joints not shown on the drawings are subject to approval by the Contracting Officer. Joints shall be perpendicular to the main reinforcement.

### 3.7.1 Construction Joints

Concrete shall be placed continuously so that structural members are monolithic in construction. Construction joints shall be located and constructed as indicated or approved. Where concrete work is interrupted by weather, end of work shift or other similar type of delay, location and type of construction joint shall be subject to approval of the Contracting Officer. Fresh concrete shall not be placed against adjacent hardened concrete until it is at least 24 hours old.

#### 3.7.1.1 Preparation for construction joints

Concrete surfaces to which other concrete is to be bonded shall be abraded in an approved manner that will expose sound aggregate uniformly without damaging the concrete. Surfaces shall be thoroughly washed and shall be damp but without free water when concrete is placed. The concrete surface shall be free of all accumulated laitance, coatings, stains, debris, loose material, and other foreign matter. Laitance shall be removed when the

concrete is sufficiently hard so that only the surface skin or mortar is removed and there is no undercutting of coarse aggregate particles. The surface shall be cleaned as the last operation prior to closing forms and obstructing the area with reinforcement.

3.7.2 Preparation for Surface Repairs

Preparation for surface repairs shall follow the requirements for preparation for construction joints, with the following additional criteria: The surface preparation shall include air-water cutting, sandblasting, high-pressure water jet, or other approved method. The surface shall be cleaned as the last operation prior to placing concrete or obstructing the area with reinforcement. The surface shall be watered for 12 hours prior to placing concrete. Horizontal surfaces shall be air blasted to remove puddled water.

3.7.3 Slabs on Grade

Non-sawn joints shall be carefully made with a jointing or edging tool. The perimeters of slabs shall be free of fins, rough edges, spalling, or other unsightly appearance.

3.7.3.1 Construction Joints for slabs on Grade

Except where otherwise indicated, the following treatment shall be constructed: Exterior slabs shall be keyed or doweled. Interior slabs shall be separated with 30 pound asphalt-saturated felt extending for the full depth of the slab. Reinforcing steel shall extend through construction joints.

3.7.3.2 Contraction Joints for slabs

Contraction joints shall be 1/4 the depth of the slab thickness and between 1/8 and 3/16 inch wide. For saw-cut joints, cutting shall be timed properly with the set of the concrete. Cutting shall be started as soon as the concrete has hardened sufficiently to prevent ravelling of the edges of the saw cut. Cutting shall be completed before shrinkage stresses become sufficient to produce cracking.

3.7.4 Waste Disposal

The method used in disposing of wastewater employed in cutting, washing, and rinsing of concrete surfaces shall be such that the wastewater does not stain, discolor, or affect exposed surfaces of the structures, or damage the environment of the project area.

3.8 FINISHING FORMED SURFACES

Beginning no more than 24 hours after form removal, all fins and loose materials shall be removed. All voids and honeycombs exceeding 1/2 inch in diameter and all tie rod holes shall be reamed or chipped and filled with dry pack mortar. Voids and honeycomb shall be dampened, brush-coated with a neat cement grout or with an approved bonding agent, and filled with mortar. The cement used in mortar for all surfaces permanently exposed to

view shall be a blend of portland cement and white cement, so that the final color when cured shall be the same as adjacent concrete. The mortar shall consist of one part cement to two and one-half parts fine aggregate. The quantity of mixing water shall be the minimum necessary to obtain a uniform mixture and to permit placing. Mortar shall be thoroughly compacted in place and struck off to adjacent concrete. Temperature of the concrete, ambient air, replacement concrete, or mortar during remedial work, including curing, shall be above 50 F. The patched areas shall be cured for seven days. Defective areas larger than 36 square inches in any surface shall be replaced or corrected as directed by the Contracting Officer.

## 3.9 FINISHING UNFORMED SURFACES

The finish of all unformed surfaces shall meet the requirements of paragraph Tolerances in PART 1, when tested as specified herein.

### 3.9.1 General

Unformed surfaces that are not to be covered by additional concrete or backfill shall have a float finish, with additional finishing as specified below, and shall be true to the elevation shown on the drawings. Unless otherwise shown on the drawings, exterior surfaces shall be sloped for drainage, as directed. Where drains are provided, interior floors shall be evenly sloped to the drains. Joints shall be carefully made with a jointing or edging tool. The dusting of surfaces with dry cement or other materials or the addition of any water during finishing shall not be permitted. If bleedwater is present prior to finishing, the excess water shall be carefully dragged off or removed by absorption with porous materials such as burlap. Slabs with surfaces which exhibit significant crazing shall be removed and replaced.

### 3.9.2 Rough Slab Finish

As a first finishing operation for unformed surfaces and as final finish for slabs to receive mortar setting beds, the surface shall receive a rough slab finish. The concrete shall be screeded with straightedge strikeoffs immediately after consolidation to bring the surface to the required finish level with no coarse aggregate visible. Side forms and screed rails shall be provided, rigidly supported, and set to exact line and grade.

### 3.9.3 Floated Finish

Screeding shall be followed immediately by darbying or bull floating before bleeding water is present, to bring the surface to a true, even plane. After the concrete has stiffened it shall be floated to a true and even plane free of ridges. Floating shall be performed by use of suitable hand floats or power driven equipment.

### 3.9.4 Troweled Finish

The finished surface shall be thoroughly consolidated and shall be steel-troweled to a smooth, even, dense finish, free from blemishes including trowel marks and be uniform in texture and appearance. A final

hard steel troweling shall be done by hand, with the trowel tipped, and using hard pressure, when the surface is at a point that the trowel will produce a ringing sound. Tolerance shall be true planes within 5/16 inch in 10 feet as determined by a 10 foot straightedge placed anywhere on the slab in any direction.

3.9.5 Broomed Finish

After floating, the surface shall be lightly steel troweled, and then carefully scored by pulling a coarse fiber push-type broom across the surface. Brooming shall be transverse to traffic or at right angles to the slope of the slab. After the end of the curing period, the surface shall be vigorously broomed with a coarse fiber broom to remove all loose or semi-detached particles.

3.10 CURING AND PROTECTION

Concrete shall be cured by an approved method for a period of 7 days, except that cement blended with pozzolan shall be cured for 14 days.

Curing of Horizontal Concrete Repairs shall be by moist curing for 7 days, no exceptions.

3.10.1 General

Immediately after placement, concrete shall be protected from premature drying, extremes in temperatures, rapid temperature change, mechanical injury and damage from rain and flowing water. Materials and equipment needed for adequate curing and protection shall be available and at the site prior to placing concrete. No fire or excessive heat, including welding, shall be permitted near or in direct contact with the concrete at any time.

3.10.2 Moist Curing

Concrete to be moist-cured shall be maintained continuously wet for the entire curing period, commencing immediately after finishing. When wooden forms are left in place during curing, they shall be kept wet at all times. Surfaces shall be cured by ponding, by continuous sprinkling, by continuously saturated burlap or cotton mats, or by continuously saturated plastic coated burlap. Burlap and mats shall be clean and free from any contamination and shall be completely saturated before being placed on the concrete. The Contractor shall have an approved work system to ensure that moist curing is continuous 24 hours per day. If inspection identifies an area of inadequate curing, immediate corrective action shall be taken, and the required curing period for those areas shall be extended by 1 day.

3.10.3 Membrane Forming Curing Compounds

Membrane curing will not be permitted on any surface to which sack-rubbed finish or smooth finish is to be applied. Membrane curing shall not be used on surfaces containing protruding steel reinforcement, or surfaces that are to receive any subsequent treatment depending on adhesion or bonding to the concrete, such as additional concrete, hardeners, sealers,

terrazzo, or abrasive aggregate finish. Clear or translucent membrane-forming compound with fugitive dye shall be used on all surfaces permanently exposed to view, and white pigmented compound may be used on all other surfaces. A styrene acrylate or chlorinated rubber compound meeting ASTM C 309, Class B requirements, may be used for surfaces which are to be painted or are to receive bituminous roofing or waterproofing, or floors that are to receive adhesive applications of resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing or flooring. Membrane curing compound shall not be used on surfaces that are maintained at curing temperatures with free steam.

Curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. All surfaces shall be thoroughly moistened with water. Curing compound shall be applied to slab surfaces as soon as the bleeding water has disappeared, with the tops of joints being temporarily sealed to prevent entry of the compound and to prevent moisture loss during the curing period. The curing compound shall be applied in a two-coat continuous operation by approved motorized power-spraying equipment operating at a minimum pressure of 75 psi, at a uniform coverage of not more than 400 square feet per gallon for each coat, and the second coat shall be applied perpendicular to the first coat. Concrete surfaces which have been subjected to rainfall within 3 hours after curing compound has been applied shall be resprayed by the method and at the coverage specified. Surfaces on which clear compound is used shall be shaded from direct rays of the sun for the first 3 days. Surfaces coated with curing compound shall be kept free of foot and vehicular traffic, and from other sources of abrasion and contamination during the curing period.

Appearance is a primary consideration for exterior concrete surfaces exposed to view. The Contractor shall exercise extreme care to apply curing compound evenly on these surfaces. Variations in shade, color, or tint, resulting from uneven application of curing compound, shall be repaired by and at the expense of the Contractor as directed.

3.10.4 Impervious Sheeting

Surfaces shall be thoroughly wetted and be completely covered with sheeting. Sheeting shall be at least 18 inches wider than the concrete surface to be covered. Covering shall be laid with light-colored side up. Covering shall be lapped not less than 12 inches and securely weighted down or shall be lapped not less than 4 inches and taped to form a continuous cover with completely closed joints. The sheet shall be weighted to prevent displacement so that it remains in contact with the concrete during the specified length of curing. Coverings shall be folded down over exposed edges of slabs and secured by approved means. Sheets shall be immediately repaired or replaced if tears or holes appear during the curing period. If inspection identifies tears, holes, laps or joints that are not completely closed, the tears and holes shall promptly be repaired or the sheets replaced, the joints closed, and the required curing period for those areas shall be extended by 1 day.

3.10.5 Ponding or Immersion

Water shall not be more than 20 degrees F less than the temperature of the concrete.

## 3.11 FLOOR HARDENER

Hardener shall be applied to all interior concrete floors that do not receive a floor covering. Prior to treatment, the floors shall be thoroughly cured, cleaned, and perfectly dry with all work above them completed. Floor hardener shall be applied after the concrete has been cured and then air dried for 28 days. Three coats shall be applied, each the day after the preceding coat was applied. For the first application of zinc silicofluoride or magnesium silicofluoride , one pound of the silocofluoride shall be dissolved in one gallon of water. For subsequent applications, the solution shall be two pounds of silicofluoride to each gallon of water. All three applications of sodium silicate shall be applied full-strength at the rate of 1/3 gallon per 100 square feet. Floor should be mopped with clear water shortly after the preceding application has dried to remove encrusted salts. Proprietary hardeners shall be applied in accordance with the manufacturer's instructions. During application, area should be well ventilated. Precautions shall be taken when applying silicofluorides due to the toxicity of the salts. Any compound that contacts glass or aluminum should be immediately removed with clear water.

## 3.12 FLOOR SEALER

Sealer shall be applied to all interior concrete floors that do not receive a floor covering or terrazzo. Prior to sealing treatment, the floors shall have received hardener treatment. Sealer shall be applied in one coat as recommended by manufacturer to improve spill and stain resistance without adversely affecting hardener. Manufacturer shall provide maintenance instructions.

## 3.13 INSULATION

Sandwiched slab insulation shall be placed on the structural slab after at least 14 days have passed and as indicated with tightly butted staggered joints. Insulation shall be protected until, and while, the cover concrete is placed.

## 3.14 EPOXY GROUTING OF DOWELS

Anchor dowels into existing concrete with a two-component epoxy adhesive, conforming to the requirements of paragraph: EPOXY ADHESIVE. Dowel diameters shown on concrete drawings are the minimum size required. The Contractor may, at his option, substitute larger diameter dowels. Holes drilled for dowels shall be of the depth indicated on the drawings and have a minimum diameter as recommended in the epoxy adhesive manufacturer's printed instructions or, if no recommendations are given, 1/8 inch larger than the bar diameter. In the event the dowel drilling encounters an obstruction, such as reinforcing steel, the dowel location may be offset a distance of two hole diameters. Hole preparation, mixing, placing, and curing of the epoxy adhesive shall be in conformance with the manufacturer's printed instructions. Pressure grouting is recommended for

holes deeper than 2 feet. Steel dowels shall conform to SECTION 03200 - CONCRETE REINFORCEMENT, paragraph: REINFORCEMENT. Steel dowels shall be dry and free from contaminants, such as rust, dirt, oil, grease, or protective coatings.

### 3.14.1 Cold Weather Epoxy Grouting

When the daily outdoor low temperature is less than 40 F, the Contractor shall provide a heated enclosure around each location where dowel grouting shall take place. The air temperature adjacent to the concrete surfaces in each dowel hole shall be heated to maintain a minimum temperature of 10 degrees F above the manufacturer's recommended minimum application temperature for the specific epoxy adhesive to be applied. Temperatures shall be measured by Contractor- furnished thermometers. The dowel enclosure shall be heated a minimum of 24 hours prior to grouting and continue through the recommended curing period for the epoxy adhesive. Immediately prior to the heating period and again immediately prior to placing grout, the air temperature at the concrete surface shall be taken at the bottom and top of every fourth dowel hole or as designated by the Contracting Officer. At least 24 hours prior to grouting, minimum temperature registering thermometers shall be placed at the bottom of four dowel holes for each group of dowels. Dowel locations will be randomly selected by the Contracting Officer. A group of dowels shall be defined as those dowels that will be embedded in a common pour of concrete. Dowel grouting may proceed, with the permission of the Contracting Officer, when none of the minimum temperatures recorded in the previous 24 hours fall below the minimum specified temperature and all temperatures recorded immediately prior to placing grout are above the minimum specified temperature. The Contractor shall maintain a log of dowel hole temperatures for inspection by the Contracting Officer prior to receiving permission. Additional cold weather measures, such as heated storage of unmixed adhesive containers and heating of dowel bars, shall follow the recommendations of the epoxy adhesive manufacturer.

## 3.15 TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL

The Contractor shall perform the inspection and tests described below and, based upon the results of these inspections and tests, shall take the action required and shall submit specified reports. When, in the opinion of the Contracting Officer, the concreting operation is out of control, concrete placement shall cease and the operation shall be corrected. The laboratory performing the tests shall conform with ASTM C 1077. If the Government conducts quality assurance testing, the Contractor shall assist in collection of samples as directed. All necessary platforms, tools, and equipment for obtaining samples shall be furnished by the Contractor.

### 3.15.1 Grading and Corrective Action

#### 3.15.1.1 Fine Aggregate

At least once during each shift when the concrete plant is operating, there shall be one sieve analysis in accordance with ASTM C 136.

#### 3.15.1.2 Coarse Aggregate

At least once during each shift in which the concrete plant is operating, there shall be a sieve analysis in accordance with ASTM C 136 for each size of coarse aggregate.

3.15.2 Concrete Mixture

a. Air Content Testing. Air content tests shall be measured when compressive strength specimens are fabricated. Specified air content shall be attained at point of placement into the forms. Measurement shall be in accordance with ASTM C 231. Additional tests shall be made when excessive variation in concrete workability is reported by the placing foreman or the Government inspector.

c. Slump Testing. The concrete slump shall be measured when compressive strength specimens are fabricated. Measurement shall be in accordance with ASTM C 143. The slump shall be reported along with the compressive strength data. Additional tests shall be performed when excessive variation in the workability of the concrete is noted or when excessive crumbling or slumping is noted along the edges of slip-formed concrete.

e. Temperature. The temperature of the concrete shall be measured when compressive strength specimens are fabricated. Measurement shall be in accordance with ASTM C 1064. The temperature shall be reported along with the compressive strength data.

f. Strength Specimens. Test cylinders shall be cast for compressive strength tests for each mix design at the following rates:

a. not less than once each day when pour exceeds 8 cubic yards.

b. not less than once for each 125 cubic yards of concrete.

c. the number of test cylinders need not exceed 3 sets per day for each mix.

A set of test specimens shall consist of four cylinders, one to be tested at 7 days and two at 28 days. If either of the 28 day breaks does not meet the specified strength, the fourth cylinder shall be tested at 90 days, otherwise it shall be discarded. Test specimens shall be molded and cured in accordance with ASTM C 31 and tested in accordance with ASTM C 39. Results of all strength tests shall be reported immediately to the Contracting Officer.

3.15.3 Inspection Before Placing

Foundations, construction joints, forms, and embedded items shall be inspected by the Contractor in sufficient time prior to each concrete placement in order to certify to the Contracting Officer that they are ready to receive concrete. Full cooperation shall be given other trades to install embedded items. Suitable templates or instructions shall be used for setting items not placed in the forms.

3.15.4 Cold-Weather Protection

At least once each shift and once per day on non-work days, an inspection shall be made of all areas subject to cold-weather protection. Any deficiencies shall be noted, corrected, and reported.

3.15.5 Reports

The results of all tests and inspections conducted at the project site, as well as corrective actions taken, shall be reported in writing weekly and shall be delivered to the quality assurance representative within three days after the end of each weekly reporting period. The Contracting Officer has the right to examine all Contractor quality control records.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 03 - CONCRETE

SECTION 03301

NON-SHRINK GROUT



-- End of Section Table of Contents --

SECTION 03301

NON-SHRINK GROUT

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of the specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

| | |
|---|---|
| ACI 347 | (1988) Recommended Practice for Concrete Formwork |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM C 31 | (1991) Making and Curing Concrete Test Specimens in the Field |
| ASTM C 109 | (1995) Compressive Strength of Hydraulic Cement Mortars (Using 2-in. Cube Specimens) |
| ASTM C 1107 | (1991)Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink) |

1.2 MEASUREMENT AND PAYMENT

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with 01330 SUBMITTAL PROCEDURES:

SD-08 Statements

Grout Plan; GA.

A detailed plan shall be submitted for approval, showing equipment and procedures proposed for use in mixing and placing the grout. The degree of fluidity proposed for use shall also be given.

SD-13 Certificates

Grout Properties; FIO.

Descriptive literature of the grout proposed for use shall be furnished together with a certificate from the manufacturer stating that it is suitable for the application or exposure for which it is being considered. Prepackaged material requiring only the addition of water will be accepted on the basis of certified laboratory test results showing that the material meets the requirements of ASTM C 1107, Grade C.

## PART 2 PRODUCTS

### 2.1 MATERIALS

Nonshrink grout shall conform to ASTM C 1107, Grade C, and shall be a prepackaged nonmetallic commercial formulation suitable for the proposed application and be proportioned to provide a minimum 28-day compressive strength of 5,000 pounds per square inch. The grout shall be mixed, placed, and cured in accordance with the grout manufacturer's written specification, or as noted by the Contracting Officer.

#### 2.1.1 Water

Water for mixing shall be free from sewage, oil, acid, alkali, salts, and objectionable quantities of silt, organic matter, and other deleterious substances. Water shall be potable. River water shall not be used.

## PART 3 EXECUTION

### 3.1 PREPARATION

Clean grout contact surfaces of oil, grease, scale, and other foreign matter. Chip away unsound concrete leaving surface level, but rough.

### 3.2 FORMWORK

Formwork shall be in accordance with ACI 347.

### 3.3 MIXING AND PLACING

Mixing and placing shall be in conformance with the material manufacturer's instructions and as specified therein. Nonshrink grout ingredients shall be thoroughly dry-mixed before adding water. After adding water, the batch shall be mixed for three minutes. Batches shall be of size to allow continuous placement of freshly mixed grout. Grout not used within 30 minutes after mixing shall be discarded. Surfaces upon which nonshrink grout is to be placed shall be clean, damp and free from frost, snow, ice, standing or flowing water, loose particles, debris and foreign matter. All equipment needed to place the nonshrink grout shall be at the placement site and in good operating condition. The space to receive grout shall be filled solid with the grout. Forms shall be of wood or other equally suitable material for retaining the grout and shall be removed after the grout has set. The placed grout shall be worked to eliminate voids. Temperature of the grout, and of surfaces receiving the grout, shall be maintained at 65 to 85 degrees F until after setting. The exposed grout's surface shall be struck level and finished to match as close as possible to the adjacent undisturbed existing concrete.

### 3.4 CURING AND PROTECTION

Nonshrink grout shall be cured and protected from premature drying, extremes in temperature, rapid temperature change, freezing, mechanical damage, and exposure to rain and flowing water, beginning immediately after placement and continuing for seven days. All materials and equipment needed for adequate curing and protection shall be available and at the site of the placement prior to start of grout placement. Preservation of moisture for grout surfaces shall be accomplished through the application

of impervious sheet material, wet curing by keeping constantly wet by means of water-soaked burlap or the application of membrane forming curing compound in accordance with the manufacturer's printed or written instructions.

## 3.5 QUALITY CONTROL

### 3.5.1 General

In accordance with the provisions of SECTION: CONTRACTOR QUALITY CONTROL, a quality control system shall be established and maintained that regulates, tests, and inspects all the procedures, equipment, materials, and personnel so that the completed project will comply with the requirements of the project specifications and the following.

### 3.5.2 Compression Test Specimens

Samples for strength tests for each mix design used shall be taken for each 9 cubic feet of grout, or once each day if less than 9 cubic feet of grout is placed. Compression test specimens for acceptance tests shall be molded, cured and tested in accordance with the applicable portions of ASTM C 31, ASTM C 109 and ASTM C 1107. Three cube specimens shall be tested at each age: 24 hours, three days and 28 days.

### 3.5.3 Records

A copy of the records of inspections, as well as the records of corrective action taken, shall be furnished to the Government as directed.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 03 - CONCRETE

SECTION 03425

PRECAST PRESTRESSED CONCRETE



-- End of Section Table of Contents --

SECTION 03425

PRECAST PRESTRESSED CONCRETE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

| | |
|---|---|
| ACI 211.1 | (1991) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete |
| ACI 315 | (1994) ACI Detailing Manual: Section Details and Detailing of Concrete Reinforcement |
| ACI 318/318R | (1995) Building Code Requirements for Structural Concrete and Commentary |
| ACI 318M | (1995) Metric Building Code Requirements for Structural Concrete and Commentary |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM A 416/416 M | (1998) Steel Strand, Uncoated Seven-Wire for Prestressed Concrete |
| ASTM C 33 | (1997) Concrete Aggregates |
| ASTM C 150 | (1997) Portland Cement |
| ASTM C 260 | (1997) Air-Entraining Admixtures for Concrete |
| ASTM C 494 | (1998) Chemical Admixtures for Concrete |
| ASTM C 618 | (1998) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete |
| ASTM C 1077 | (1998) Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation |
| ASTM C 578 | (1995) Rigid, Cellular Polystyrene Thermal Insulation |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.1 | (1998) Structured Welding Code - Steel |

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

| | |
|---|---|
| PCI Mnl-116S | (1985) Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products |
| PCI Mnl-117 | (1996) Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products |
| PCI Mnl-122 | (1989) Architectural Precast Concrete |

## 1.2 GENERAL REQUIREMENTS

Precast concrete units shall be designed and fabricated by an experienced and acceptable precast concrete manufacturer certified under the PCI Plant Certification Program. The manufacturer shall have been regularly and continuously engaged in the manufacture of precast concrete work similar to that indicated on the drawings for at least 3 years. Precast work shall be coordinated with the work of other trades.

### 1.2.1 Appearance

Abrupt variations in color, shade, or tint of the exterior surfaces will not be permitted. Use of pozzolan and surface sealers shall be controlled to limit discoloration. Exterior surfaces shall be protected from stains or abrasions.

#### 1.2.1.1 Coloring

The concrete shall be colored buff-grey to match the cast-in-place foundation and the existing lock and dam concrete. Pigments may be added at the Contractor's option to reduce color variations of the panels. Color additives shall be selected dependent on the natural color of the concrete. Color additives shall be proported before the start of production, and used consistently for all panels. The color shall be approved by the Contracting Officer based on the submitted samples. The color desired by the Contracting Officer is approximately the color strip indicated by Solomon Colors for product 238 Buff, or 288 Buff for 1 bag per 4 yards.

## 1.3 DESIGN

Precast unit design shall conform to ACI 318/318R and PCI Mnl-122. Stresses due to restrained volume change caused by shrinkage and temperature differential, handling, transportation and erection shall be accounted for in the design. Design shall include the analysis of member for lifting stresses and the sizing of the lifting inserts.

### 1.3.1 Connections

Connection of units to other members, or to other units shall be of the type and configuration indicated. The design and sizing of connections for

all design loads shall be by the Contractor.

1.3.2 Concrete Strength

Precast concrete units shall have a 28-day compressive strength of 5000 psi.

1.3.3 Concrete Proportion

Selection of proportions for concrete shall be based on the methodology presented in ACI 211.1 for normal weight concrete. The concrete proportion shall be developed using the same type and brand of cement, the same type and gradation of aggregates, and the same type and brand of admixture that will be used in the manufacture of precast concrete units for the project. Calcium chloride shall not be used in precast concrete and admixtures containing chloride ions, nitrates, or other substances that are corrosive shall not be used in prestressed concrete.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Calculations; FIO.

Design calculations shall be submitted prior to the initiation of manufacture of members to be used under this contract. Design calculations shall be certified by a registered professional engineer licensed in the State of Minnesota or Wisconsin.

Mix Design; FIO.

A statement giving the maximum nominal coarse aggregate size, the proportions of all ingredients and the type and amount of any admixtures that will be used in the manufacture of each strength and type of concrete, prior to commencing operations. The ingredient list shall include type, color and proportion of any coloring agents, if used. The statement shall be accompanied by test results from a testing laboratory complying with ASTM C 1077 certifying that the proportions selected will produce concrete of the properties required. No substitutions shall be made without additional tests to verify that the concrete properties are satisfactory.

SD-04 Drawings

Precast Concrete System; GA.

Detail drawings showing details in accordance with ACI 315 and ACI 318/318R, including installation details. Detail drawings shall indicate separate identification marks for each different precast unit, location of units in the work, elevations, fabrication details, welding details, reinforcement, connections, dimensions, interface with adjacent members, blocking points for units stored at the precast concrete plant or at the jobsite, lifting points and special handling instructions in sufficient detail to cover manufacture, handling, and erection.

SD-09 Reports

Materials; FIO.

Certified copies of test reports including all test data and all test results. Tests for compressive strength of concrete shall be performed by an approved independent commercial testing laboratory, except that compressive strength tests for initial prestress may be performed in the manufacturer's plant laboratory.

SD-14 Samples

Precast Concrete Units; GA.

Before casting precast members, 3 sample panels of precast concrete not less than 12 inches wide, 12 inches deep and 3 inches thick shall be submitted with proposed surface texture, including surface sealer and coloring if used. The samples shall be cured similar to production panels and cast with ample time to allow the surfaces to dry to a representative color and shade prior to submittal. After approval, the sample panel(s) shall be retained at the jobsite to serve as the standard of quality for texture, surface finish, and concrete color.

## 1.5 DELIVERY, HANDLING AND STORAGE

### 1.5.1 Transportation

In transporting members by truck, railroad car or barge, provision shall be made for supporting the members as described above, except battens may be continuous over more than one stack of units, with adequate bracing to insure their maintaining the vertical position and damping of dangerous vibrations. Trucks with double bolsters are generally satisfactory provided the members are fully seated on the outer bolsters at not more than 3 ft or the depth of the member from the end and the inner bolster is not more than 8 ft from the end of the member or the designated pickup point. Adequate padding material shall be provided between tie chains or cables to preclude chipping of concrete. Any noticeable indication of lateral deflection or vibration during transportation shall be corrected by rigid bracing between members or by means of lateral trussing.

### 1.5.2 Handling

a. The location of pickup points for handling of the members and details of the pickup devices shall be shown on shop drawings. Members shall be handled only by means of approved devices at designated location.

b. Storage areas for prestressed members shall be stabilized, and suitable foundations shall be provided, so differential settlement or twisting of members will not occur.

c. Stacked members shall be separated and supported by battens placed across the full width of each bearing point. Battens shall be arranged in vertical planes at a distance not greater than the depth of the member from designated pickup points. Battens shall not be continuous over more than one stack of precast units. Stacking of members shall be such that lifting devices will be accessible and undamaged. The upper members of a stacked tier shall not be used as storage areas for shorter members or equipment.

### 1.5.3 Storage and Inspection at Manufacturer's Plant

Precast units temporarily stored at the manufacturer's plant shall be protected from damage in accordance with PCI Mnl-116S, PCI Mnl-117 and PCI Mnl-122. Immediately prior to shipment to the jobsite, all precast concrete units shall be inspected for quality to insure all precast units conform to the requirements specified. Inspection for quality shall include, but shall not necessarily be limited to, the following elements: color, texture, dimensional tolerances, chipping, cracking, staining, warping and honeycombing. All defective precast concrete units shall be replaced or repaired as approved.

## PART 2 PRODUCTS

### 2.1 MATERIALS

Except as otherwise specified, material shall conform to Section 03300 CONCRETE FOR BUILDING CONSTRUCTION. In no event shall admixtures containing chlorides or nitrates be used in the concrete.

a. Portland cement shall conform to ASTM C 150, Type I, II, or III.

b. Pozzolan shall conform to ASTM C 618, Class F.

c. Aggregates shall meet the requirements of ASTM C 33.

d. Air-entraining admixture shall be certified to comply with ASTM C 260.

e. Water-reducing admixture shall be certified to comply with ASTM C 494.

f. Reinforcement shall be in accordance with Section 03200 CONCRETE REINFORCEMENT.

g. Prestressing Strands. Prestressing strands shall conform to ASTM A 416/A 416M.

h. Insulation for Sandwiched Panels. Insulation sandwiched in wall panels shall be 3 inch thick polystyrene insulation in accordance with ASTM C 578, Type IV.

i. Reglets. In accordance with SECTION: METAL ROOFING, FACTORY-COLOR-FINISHED.

j. Tie wire shall be soft monel or 18-8 stainless steel.

### 2.2 PRECAST CONCRETE UNITS

Precast concrete units shall be manufactured and cured in accordance with the applicable provisions of PCI Mnl-116S and PCI Mnl-117. Units shall be manufactured within the allowable tolerances given in PCI Mnl-116S, PCI Mnl-117 and PCI Mnl-122.

### 2.2.1 Formwork

Forms shall be steel of adequate thickness, braced, stiffened, anchored and

aligned to produce precast concrete units within required dimensional tolerances. Forms shall be sufficiently rigid to provide dimensional stability during handling and concrete placement and consolidation. Fiberglass-reinforced plastic, plastic coated wood, elastomeric or other nonabsorptive material shall be used for making tight joints and rustication pieces.

2.2.2 Reinforcement

Fabrication and placement of reinforcement shall conform to the details shown on the approved detail drawings and PCI Mnl-116S and PCI Mnl-117.

2.2.3 Identification

Each precast concrete unit shall be marked to correspond to the identification marks for each different precast unit shown on the detail drawings.

2.2.4 Finishes

Interior exposed wall surfaces shall have a steel trowel finish as specified in SECTION: CONCRETE FOR BUILDING CONSTRUCTION. Exterior (formed) surfaces shall have smooth surfaces from being cast against steel forms. Exterior surfaces shall simulate a smooth cast-in-place finish (similar to the existing lock and dam structure), with reveals cast as shown. Formed surfaces shall match the texture and color of the approved sample panels. Particular attention shall be paid to the uniformity of color and texture between panels and within panels of the exterior surfaces. Special care shall be taken to avoid excess form oil on the forms where surfaces are required to be painted or scheduled to receive other applied finishes. Fins and large protrusions shall be removed. Large holes shall be filled. All faces shall have true, well-defined surfaces. Exposed ragged edges shall be corrected by rubbing or grinding.

2.2.5 Tolerances

The precast prestressed members shall be manufactured within the following tolerances. Members that fail to meet the dimensional tolerances shall be rejected.

a. Length of Member. The length of the member shall not deviate from the length shown on the approved shop drawings by more than 3/4 inch or 1/8 inch per 10 feet of length, whichever is greater.

b. Cross-Sectional Dimensions. The cross-sectional dimensions of a member, if less than 36 inches, shall not vary by more than 1/4 inch and, if over 36 inches, shall not vary by more than 3/8 inch.

c. Vertical Alignment (Sweep). The alignment of the members shall not deviate from a straight line parallel to the theoretical center line by more than 1/4 inch. The maximum gap between two adjacent members due to sweep shall not exceed ½ inch. The typical joint width shall be 1/4 inch.

d. Position of Tendons. The position of the tendons shall not deviate from the design position by more than 1/4 inch.

e. Handling Devices. The actual position of handling devices shall not deviate from the design position by more than 6 inches.

f. Anchors and Inserts. The actual position of anchors and inserts shall not vary by more than 1 inch from positions shown on the approved shop drawings.

g. Slab Thickness. The thickness of the slab shall not vary from the dimensions on the drawings by more than 1/8 inch.

h. Squareness of Ends. The ends of members shall not deviate from being square by more than 1/4 inch. Squareness shall be checked in both the vertical and horizontal planes.

2.2.6 Defects

Minor Defects involve less than 36 square inches of concrete, do not expose stressing tendons or reinforcing steel, and include cracks that are visible, but are 0.01 inch wide or less. Minor defects will be repaired as specified hereinafter. Major defects are those that involve more than 36 square inches of concrete or expose stressing tendons or reinforcing steel. If one or more major defects appear in a member, it shall be rejected. Cracks of a width of more than 0.01 inch shall be cause for rejection of the member.

2.2.6.1 Repair of Minor Defects

All honeycombed areas, chipped corners, air pockets over 1/4 inch in diameter, and other minor defects as defined hereinbefore shall be repaired. Form offsets of fins over 1/8 inch shall be ground smooth. All unsound concrete shall be removed from defective areas prior to repairing. Repairs shall be by a blend of portland cement and white cement properly proportioned so that the final color when cured will be the same as adjacent concrete.

2.3 WEEP HOLES

Weeps shall be 3/8" sash cord that is groutted in.

PART 3 EXECUTION

3.1 ERECTION

Precast units shall be erected in accordance with the detail drawings and without damage to other units or to adjacent members. Units shall be set true to alignment and level, with joints properly spaced and aligned both vertically and horizontally. Erection tolerances shall be in accordance with the requirements of PCI Mnl-117 and PCI Mnl-122. As units are being erected, shims and wedges shall be placed as required to maintain correct alignment. After final attachment, precast units shall be grouted as shown. After erection, welds and abraded surfaces of steel shall be cleaned and touched-up with a zinc-rich paint. Welds shall be made by a certified welder in accordance with the manufacturer's erection drawings. When welding or burning with a welding electrode, the ground shall be attached directly to the base metal. Under no circumstances shall the member be used as a conductor for the ground. Pickup points, boxouts, inserts, and similar items shall be finished to match adjacent areas after erection. Erection of precast units shall be supervised and performed by workmen skilled in this type of work. Welding and the qualifications of welders shall be in accordance with AWS D1.1.

## 3.2 JOINT SEALING

Joints shall be sealed as specified in Section CAULKING AND SEALING.

## 3.3 WEEP HOLES

Weeps shall be 3/8" sash cord that is groutted in. Weeps shall be located between the first floor precast panel and the foundation monolith (Elevation -0'-6"). Weeps are to be located under every vertical panel joint that encloses the building and is above grade. Intermediate weeps are to be spaced at 2'-0" between the vartical panel joints. Weeps shall pentrate the full depth or 12" to the back side of the precast panel.

## 3.4 CLEANING

Not sooner than 72 hours after joints are sealed, faces and other exposed surfaces of precast concrete discolored during erection shall be cleaned to remove dirt and stains by dry scrubbing with a stiff fiber brush, wetting the surface and vigorous scrubbing of the finish with a stiff fiber brush followed by additional washing, or by chemical cleaning compounds such as detergents or other commercial cleaners. Commercial cleaners shall be used in accordance with the manufacturer's recommendations. Cleaning procedure shall be performed on a designated test area and shall be approved prior to proceeding with cleaning work. Discolorations which cannot be removed by these procedures, will be considered defective work. Cleaning work shall be done when temperature and humidity permit surfaces to dry rapidly. Adjacent surfaces shall not be damaged during cleaning operations.

## 3.5 QUALITY CONTROL TESTING

Quality control testing shall be in accordance with section 03300 CONCRETE FOR BUILDING CONSTRUCTION.

## 3.6 DEFECTIVE WORK

Precast concrete units damaged during erection shall be repaired as soon after occurrence as possible or replaced, as directed, using approved procedures. All repairs to precast concrete units shall match the adjacent surfaces in color and texture and shall be as approved. Unless otherwise approved, repair procedures shall conform to PCI Mnl-116S and PCI Mnl-117.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 03 - CONCRETE

SECTION 03900

HORIZONTAL AND VERTICAL CONCRETE SURFACE REPAIRS

SECTION 03900

HORIZONTAL AND VERTICAL CONCRETE SURFACE REPAIRS

PART 1 GENERAL

The work under this section shall include the removal and disposal of deteriorated concrete from the existing lock wall monoliths and guide walls, and the furnishing and installation of cast-in-place concrete work and joint sealing for the repair of monolith surfaces, cracks, and joints. Horizontal surface concrete replacement at the lock wall monoliths and light standard supports is specified in SECTION: CONCRETE FOR BUILDING CONSTRUCTION; concrete removal is covered herein.

Fiber-reinforced acrylic polymer modified concrete is designated as FRAPMC herein after. FRAPMC consists of mortar, coarse aggregate, and fiber reinforcement, and shall be used for vertical surface repair.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

| | |
|---|---|
| ACI 301 | (1996) Standard Specification for Structural Concrete |
| ACI 305 | (1991) Hot Weather Concreting |
| ACI 306.1 | (1990) Cold Weather Concreting |
| ACI 548.1 | (1997) Guide for the Use of Polymers in Concrete |

CONCRETE SAWING AND DRILLING ASSOCIATION (CSDA)

| | |
|---|---|
| CSDA W-1 | ( ) Concrete Wall Sawing |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM A 563 | (1997) Carbon and Alloy Steel for Nuts |
| ASTM C 31/C 31M | (1998) Making and Curing Concrete Test Specimens in the Field |
| ASTM C 33 | (1997) Concrete Aggregates |
| ASTM C 39 | (1996) Compressive Strength of Cylindrical Concrete Specimens |
| ASTM C 109 | (1998) Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] |

| | |
|---|---|
| | Cube Specimens) |
| ASTM C 144 | (1997) Aggregate for Masonry Mortar |
| ASTM C 150 | (1997) Portland Cement |
| ASTM C 685 | (1998) Concrete Made by Volumetric Batching and Continuous Mixing |
| ASTM C 882 | (1991) Bond Strength of Epoxy-Resin System Used with Concrete By Slant Shear |
| ASTM C 920 | (1998) Elastomeric Joint Sealant |
| ASTM C 1042 | (1991) Bond Strength of Latex Systems Used with Concrete by Slant Shear |
| ASTM C 1116 | (1997) Fiber-Reinforced Concrete and Shotcrete |
| ASTM D 3405 | (1997) Joint Sealants, Hot-Applied for Concrete and Asphalt Pavements |
| ASTM D 3574 | (1995) Flexible Cellular Materials, Slab, Bonded, and Headed Urethane Foams |

FEDERAL SPECIFICATIONS (FED SPEC).

| | |
|---|---|
| FF-S-325 | ( ) Shield, Expansion; Nail Expansion; AM (3) and Nail Drive Screw (Devices, Anchoring, Masonry) |

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Instructions

FRAPMC; FIO.

Manufacturer's literature, including surface preparation, mixing and application procedures. One copy of the instructions shall be kept available at the job site at all times while this work is being performed.

One-Component, Polymer Modified, Cement Based, Flowable Surface Repair Mortar; FIO.

Manufacturer's literature, including surface preparation, mixing and application procedures of the mortar. One copy of the instructions shall be kept available at the job site at all times while this work is being performed.

Horizontal Crack Sealant; FIO.

Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the materials,

printed copies of these recommendations shall be furnished prior to use on the project. Installation of the material shall not be allowed until the recommendations are received. One copy of the instructions will be kept available at the jobsite at all times while this work is being performed.

SD-07 Schedules

Concrete Repair Schedule; FIO.

A construction schedule for the repair work to be performed under this section shall be submitted.

SD-08 Statements

Concrete Removal and Disposal Scheme; GA.

The Contractor shall submit a written proposal outlining the proposed procedure for removing damaged concrete from the lock wall monoliths and guide wall surfaces, and the methods of retaining and disposal of all debris.

FRAPMC Forming Scheme; FIO.

Installation procedure shall include a typical formwork detail for a spalled area (for which the limits of removal do not extend to the top of the wall), including a description of how the Contractor plans to install the formwork, place and consolidate the FRAPMC behind the formwork, and remove the formwork without damaging the newly placed material.

SD-09 Reports

Vertical and Horizontal Joint Sealants and Accessories; FIO.

Certified manufacturer's test reports shall be provided for the elastomeric sealant, foam grout joint filler, and butyl rod to verify compliance with applicable specifications.

FRAPMC Test Results; FIO.

Submit reports from testing required under this section.

SD-13 Certificates

Joint Filler; FIO.

Written certificates certifying that the installer of joint filler has been doing this work for at least two years. The written certificate shall be submitted and signed by the manufacturer of the joint filler material.

FRAPMC; FIO.

Each applicable supplier shall provide a signed certification that cement, aggregates, and additives conform to the requirements specified herein.

SD-14 Samples

Field-Molded Sealant and Primer; FIO.

One 16-ounce tube of field-molded sealant shall be provided for testing.

Also provide one container of primer when use of primer is recommended by the sealant manufacturer.

Joint filler materials; FIO.

Joint filler materials shall be submitted for inspection and testing and shall be identified to indicate manufacturer, type of material, size and quantity of material, and shipment represented. One gallon of this material shall be provided as a sample for testing.

Horizontal Crack Sealant and Primer Samples; FIO.

One 16-ounce tube of the sealant shall be provided for testing. Also provide one container of primer or bond break compound.

## 1.3 PREVIOUS EXPERIENCE

The St. Paul District has used FRAPMC for concrete repair at several similar locations. That experience indicates special forming materials may be necessary to prevent problems associated with material flow and aggressive bonding to the forms. Satisfactory results were obtained using polyethylene board for forms and disintegratable board for joints. This information is provided to alert bidders to the potential for abnormal conditions and is not an endorsement or recommendation of the above materials or procedures.

## 1.4 WEATHER LIMITATIONS

Refer to SECTION: GENERAL for time restrictions.

### 1.4.1 Cold Weather

Cold weather concreting shall be in accordance with ACI 306, except as modified herein. When daily low temperatures are below freezing and/or when it is likely that temperatures will be below freezing within seven days of the concrete placement, provide protection, heat, and/or heated materials so as to maintain the concrete at 45 degrees F to 65 degrees F for the complete seven-day curing period. Provide sufficient thermometers, controls, and supervision to ensure that these requirements are being met. Maintain the protection so that concrete does not cool at more than 20 degrees F per 24 hours. Heating devices used shall not blow or radiate intense heat directly at concrete or formwork. Heating devices used shall not discharge products of combustion into enclosures. Maintain the required curing as specified hereinafter.

### 1.4.2 Hot Weather

Hot weather concreting shall be in accordance with ACI 305, except as modified herein. When weather conditions are such that excessive drying and/or premature set is liable to occur, provide wind screens, shading, and/or cooled materials so as to prevent these conditions and to provide good finishing conditions, as applicable. If crushed ice is used, it must be 100 percent melted before discharge of the materials from the mixer.

## 1.5 EQUIPMENT

Equipment that is dependable and adequate to accomplish the specified work shall be assembled at the work site in sufficient time before the start of the work to permit thorough inspection, calibration of weighing and

measuring devices, adjustment of parts, and the making of any repairs that may be required. The equipment shall be maintained in acceptable working condition during the life of the project.

### 1.5.1 Sandblasting

Sandblasting equipment shall include an air compressor, hose, and long-wearing venturi-type nozzle of proper size, shape and opening. The maximum nozzle opening shall not exceed 1/4 inch. The air compressor shall be capable of maintaining a line pressure of not less than 90 psi at the nozzle while in use. The compressor shall be equipped with traps that will maintain the compressed air free of oil and water. The height, angle of inclination and the size of the nozzle shall be adjusted as necessary to provide satisfactory results. The Contractor shall provide protective covers and barriers as required to prevent over-spray onto adjacent surfaces.

### 1.5.2 Concrete Router

A self-propelled power router shall be provided for routing cracks to the specified widths and depths and for removing filler or other foreign material embedded in the cracks or joint or adhering to the crack or joint faces.

## 1.6 STORAGE OF MATERIALS

Labeling of packages shall clearly define contents, manufacturer, batch identification, etc. Aggregate stockpiles shall be arranged and used in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of aggregates. Epoxy and acrylic modified cement shall be stored in accordance with the manufacturer's recommendations.

# PART 2 PRODUCTS

## 2.1 MATERIALS

The manufacturer and products listed represent the nature and quality of products required for satisfactory performance of the work and are not intended to prohibit the selection of equivalent products by other manufacturers.

### 2.1.1 FRAPMC

Concrete mortar shall be a self-leveling, acrylic polymer modified cementitious system consisting of two components. FRAPMC shall comply with ACI 548.1, except as modified herein.

Component A: Prepackaged liquid polymer emulsion of acrylic polymer and additives.

Component B: Mixture of cements, aggregates, and admixtures.

Mortar shall not contain chlorides, nitrates, added gypsum, lime, or high alumina cements. Accelerators and admixtures shall be premixed as part of either Component A or B. Mortar shall be noncombustible before and after curing. Color of cured mortar shall be concrete gray. Mortar shall require no bonding agent to be applied to the substrate prior to placing

the mortar to achieve the specified performance. Cured mortar shall not produce a vapor barrier. Mortar shall be thermally compatible with existing concrete and be freeze thaw-resistant. The mortar shall be compatible with polypropylene fiber. The addition of fiber shall not have an adverse affect on the performance of the mortar.

2.1.2 Fiber reinforcement

Fiber reinforcement shall be 1-1/2 inch length, fibrillated polyolefin fiber made from virgin polypropylene meeting the requirements for Type III fibers per ASTM C 1116.

2.1.3 Expansion anchor

Expansion anchor shall be 3/4 inch anchor bolt, including expansion sleeve and nut conforming to Fed Spec FF-S-325, Group VIII, Type 2. Nuts shall be hex type and shall conform to ASTM A 563.

2.1.4 Coarse aggregate

Coarse aggregate shall meet all the requirements of the mortar manufacturer, be saturated surface dry, and conform to ASTM C 33, size designation No. 8. Crushed limestone will not be permitted.

2.1.5 Water

Water shall be fresh and free from injurious amount of oil, acid, salt, alkali, organic matter, or other deleterious substances. Water shall be potable. River water shall not be used.

2.1.6 Vertical and Horizontal Joint Materials

a. Elastomeric Joint Sealant. Elastomeric Joint Sealant shall be a cold appled type as specified in SECTION 03150 - EXPANSION JOINTS, CONTRACTION JOINTS, AND WATER STOPS.

b. Bond Breaker. Bond breaker material shall be polyethylene tape, coated paper, metal foil, or similar type materials. Joint sealant shall be used with the manufacturer's specified primer.

c. Joint Backer Rod. The backup material shall be compressible, non-shrink, nonreactive with sealant, and nonabsorbent material type, such as extruded butyl, polyolefin foam or polychloroprene foam rubber, oversized 30 to 50 percent.

d. Oakum. Dry, unoiled, and twisted jute.

e. Elastomeric Filler for Vertical Joint Repair. Elastomeric filler shall be a hydrophobic closed-cell polyurethane foam. The polyurethane resin shall be based on MDI in combination with polyether polyols. The material shall expand and cure to a tough, flexible, elastomeric condition. The material shall be suitable for use in an outdoor environment subjected to cyclic hydrostatic loads. The cured material shall have a minimum tear resistance of 20 lb/in, a minimum tensile strength of 50 psi and a minimum elongation of 200 percent when tested in accordance with ASTM D 3574. The gel time shall be varied as deemed necessary for the field condition of each joint. Material shall be stored, handled, and protected after delivery to the site as recommended by the manufacturer. Elastomeric filler for vertical joint

repair is also referred to as foam grout joint filler.

2.1.7 Horizontal and Light Standard Support

Concrete for horizontal and light standard support repairs shall be as specified in SECTION: CONCRETE FOR BUILDING CONSTRUCTION.

2.1.8 Polymer Modified Mortar

One-Component, Polymer Modified, Cement Based, Flowable Surface Repair Mortar. Concrete mortar shall be a prepackaged commercial formulation consisting of a one-component polymer modified, shrinkage-compensated cementitious system suited for resurfacing distressed horizontal concrete surfaces. The mortar shall comply with ACI 548.

The prepackaged mortar shall have a standard thickness application range of 1/4 inch to 1 inch. This thickness shall be extendable to 3 inches with the addition of 3/8 inch pea gravel. The mortar, without aggregate extension shall be proportioned to provide a minimum 28-day compressive strength of 7,500 pounds per square inch, when tested in accordance with ASTM C 109, and a minimum 28-day slant shear bond strength of 2500 psi when tested in accordance with ASTM C 1042.

Color of cured mortar shall be concrete gray. Mortar shall require no bonding agent to be applied to the substrate prior to placing the mortar to achieve the specified performance. Cured mortar shall not produce a vapor barrier. Mortar shall be thermally compatible with existing concrete and be freeze thaw-resistant.

PART 3 EXECUTION

3.1 VERTICAL SURFACES AND JOINT REPAIR

3.1.1 Surface Preparation

The Contractor shall sound the concrete surfaces of the lock walls and guide walls in the presence of the Contracting Officer to determine the actual extent of concrete removal required. Approximate locations and areas are indicated on the drawings. Actual locations and limits of deteriorated concrete shall be determined by visual inspection and by rapping with a hammer or 5/8 inch steel rod. A dull or hollow sound from the rapping shall indicate that the concrete is defective. The Contractor shall mark the lines on the concrete that shall be the limits of concrete removal as approved by the Contracting Officer. Limits of repair at the joints will be as shown on the drawings or as otherwise directed, based on the above methods. Saw- cut perimeter of areas to be repaired as indicated and remove all deteriorated concrete. Saw-cutting shall be omitted where prohibited by existing embedded wall armor. Sawing shall be in accordance with CSDA W-1, except as specified herein and removal shall be by chipping hammers or other approved means. The depth of removal shall be as approved by the Contracting Officer, but not less than the minimum as indicated on the drawings, nor more than is required to reach sound concrete. All reinforcement and embedded metalwork shall be preserved. Minor chipping may be required within the joint to ensure a uniform joint slot that can be filled completely with sealant. After removal of unsound concrete, surfaces shall be thoroughly cleaned with sandblasting, unless otherwise approved. Surface cleaning shall be done from the top towards the bottom on vertical surface repairs and shall be continued until all debris and

loose fragments are removed. After sandblasting, the surface shall be rinsed with clean water. Care shall be taken so that the sandblasting does not leave a polished surface.

3.1.2 Anchors

Install anchors in accordance with the manufacturer's recommendations.

3.1.3 Mixing FRAPMC

FRAPMC shall be used for all repairs in this paragraph, except where shown otherwise on the drawings. The mortar shall be mixed mechanically in an appropriate sized mortar mixer and in quantities that can be placed within 30 minutes, or less if recommended by the manufacturer. The addition rate of aggregate shall not exceed 42 pounds per 0.5 cu ft of mortar. Crushed, angular, or dry stone will cause a stiffer mix. Fibers shall be used at the rate of 1.6 pounds per cu yd of mixture. At the beginning of each mixer batch, for one to two minutes or as recommended by the fiber manufacturer's instructions, add and mix the fibers and coarse aggregate with a portion of Component A to disperse and condition the fibers. After the fibers are adequately conditioned and dispersed, add and mix, for three minutes or as designated by the manufacturer, Component B and the remainder of Component A as required to obtain a uniform consistency. Additional amounts of Component A may be necessary for workability if the manufacturer's instructions and Component A quantity do not allow for the inclusion of fibers and aggregate.

3.1.4 Placing FRAPMC

Concrete surfaces against which FRAPMC is to be placed shall be damp with no glistening water evident at the time of application. No bond coat or primer shall be used. Surfaces shall be between 50 F and 80 F at the time of placement. The FRAPMC shall be poured in place using appropriate formwork and so that all voids in the repaired area are filled. Concrete replacement at vertical joints shall be made on both sides of the joint at the same time. Suitable means shall be provided to maintain the joint slot as indicated.

3.1.5 Curing FRAPMC

Curing and finishing shall be in accordance with the manufacturer's instructions. Unless otherwise specified, FRAPMC shall be cured for a minimum of 24 hours using wet burlap, polyethylene sheeting, or a nonsolvent FRAPMC compatible curing compound. The newly placed FRAPMC shall be maintained at 50 F for at least the first 24 hours and protected from freezing for an additional four days.

3.2 JOINT SEALANT INSTALLATION

3.2.1 Sequence

Concrete repairs will be performed at monolith joints as indicated and specified. The Contractor shall be responsible for keeping each joint free of debris. Prior to installation of any joint materials, the sides of the joints shall be cleaned by routing and sandblasting as indicated on the drawings. Installation of oakum material and joint backer material and joint sealant shall be started at each joint no sooner than three days after completion of repairs at that joint. Care shall be exercised to avoid application of joint material on the face of the lock walls or other

exposed concrete surfaces.

3.2.2 Installation of Foam Grout Joint Filler

In addition to the guidance and instructions specified here, the Contractor shall offer his own guidance and expertise concerning the best filling procedures to be used. If the Contractor does not have at least two years' experience installing the joint filler, he shall employ the services of a chemical grouting company who has this experience or he shall obtain the services of a qualified employee from the joint filler manufacturer's company to act as a consultant on the jobsite. The consultant shall be present on the jobsite during the installation of the first two joints and remain at the site until he and the Government are satisfied that the joints have been filled satisfactorily. Immediately prior to filling, each joint shall be cleaned in accordance with the grout manufacturer's recommendations. Oakum shall be installed as shown and before joint filling commences. The filler shall be installed in such a manner that it is totally confined along the top, sides, and bottom of each joint during installation to ensure that total penetration of all voids is attained by the filler.

3.2.3 Elastomeric Joint Sealer

Joints shall not be sealed when the sealant, air, or concrete temperature is less than 40 degrees F. Bond breaker and backup material shall be installed where required. Joints shall be primed and filled flush with joint sealant in accordance with the manufacturer's recommendations and as shown on the drawings. Joint sealant shall not be installed at each joint until after installation of foam grout joint filler has been completed, and no sooner than three days after concrete repairs have been completed, at each joint.

3.3 HORIZONTAL SURFACE AND LIGHT STANDARD SUPPORT REPAIR

3.3.1 Surface Preparation

The Contractor shall sound the concrete surfaces of the lock walls and guide walls in the presence of the Contracting Officer to determine the actual extent of concrete removal required. Approximate locations and areas are indicated on the drawings. Actual locations and limits of deteriorated concrete shall be determined by visual inspection and by rapping with a hammer or 5/8 inch steel rod. A dull or hollow sound from the rapping shall indicate that the concrete is defective. The limits of sound concrete removal for drainage purposes shall be as indicated on the drawings and as directed by the Contracting Officer. The Contractor shall mark the lines on the concrete that shall be the limits of concrete removal as approved by the Contracting Officer. Limits of repair will be as shown on the drawings or as otherwise directed, based on the above methods. Saw-cut perimeter of areas to be repaired as indicated, and remove all deteriorated concrete. Sawing shall be in accordance with CSDA W-1, except as specified herein, and removal shall be by saw-cutting, high-pressure water jet, planing, or grinding, or other approved means. Chipping hammers with hammer weight not exceeding 30 pounds may be used in areas inaccessible by listed allowed methods. The depth of removal shall be as approved by the Contracting Officer, but not less than the minimum as indicated on the drawings, nor more than is required to reach sound concrete. All reinforcement and embedded metalwork shall be preserved. After removal of unsound concrete, surfaces shall be thoroughly cleaned with sandblasting, unless otherwise approved. After sandblasting, the

surface shall be rinsed with clean water. Care shall be taken so that the sandblasting does not leave a polished surface.

## 3.4 HORIZONTAL CRACK REPAIR

### 3.4.1 Routing

A power-driven concrete router shall be used to route cracks in existing concrete monoliths; until the groove is clear and open to the full indicated width and depth. Loosened material shall be blown from the groove.

### 3.4.2 Preparation of Cracks

Immediately before installation of the sealant, the joints shall be thoroughly cleaned by blasting with compressed air until all dust, debris, and other foreign material are removed from the space to be sealed. Crack repair locations shall have continuation of crack plugged and have a bond break applied to "floor" of routed joint. Where cracks extend through surfaces to be patched, the patch shall be made first and then the original line of the cracks shall be tooled or routed into the patched area.

### 3.4.3 Rate of Progress

The stages of joint preparation, which include air pressure cleaning of joint and placement of bond breaker or blocking media, shall be limited to only that lineal footage that can be sealed during the same workday.

### 3.4.4 Time of Application

Routed cracks shall be sealed immediately following the crack routing and cleaning process, or as soon thereafter as weather conditions permit. Concrete walls of the routed crack shall be surface dry, and the atmospheric and concrete temperatures shall be above 50 F at the time of application of the sealant. Open routed cracks that cannot be sealed under the conditions specified herein shall be provided with an approved temporary seal to prevent infiltration of foreign particles. Wet routed cracks shall be dried prior to installing sealants.

### 3.4.5 Sealing

No sealant shall be installed until the cleaned routed cracks have been inspected and approved. The routed cracks shall be filled from the bottom up and have the top surface tooled as indicated or as recommended by the manufacturer. Routed cracks shall be checked frequently to ensure that the newly installed sealant is cured to a tack-free condition within three hours.

## 3.5 CONCRETE SURFACE REPAIR WITH POLYMER MODIFIED MORTAR

Remove a minimum of 1/4 inch of existing concrete facing and continue removal as required to expose sound aggregate. Substrate should have a minimum amplitude of 1/8 inch. Chipping hammers if used shall not exceed 15 lb. Thoroughly clean the roughened surface of dirt, loose chips and dust using high pressure water. Maintain substrate in a saturated surface dry condition. Place, screed, finish and cure flowable mortar per manufacturers instructions.

## 3.6 TESTING FRAPMC

Test specimens shall be prepared in sets of three 4 inch by 8 inch cylinders, in accordance with ASTM C 31, taken from the mixes of each day's placement. Testing shall be in accordance with ASTM C 39. Of each set of three cylinders made, one shall be tested at three days and two at 28 days. Testing shall be performed by an independent testing laboratory at the expense of the Contractor. FRAPMC shall have a compressive strength of not less than 2,500 psi at three days and not less than 4,500 psi at 28 days. Bond strength as tested in accordance with ASTM C 882 shall not be less than 1,100 psi at 28 days.

-- End of Section --l

SECTION TABLE OF CONTENTS

DIVISION 03 - CONCRETE

SECTION 03930

EPOXY-INJECTED CRACK REPAIR



-- End of Section Table of Contents --

SECTION 03930

EPOXY-INJECTED CRACK REPAIR

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM C 321 | (1997) Bond Strength of Chemical-resistant Mortars |
| ASTM C 881 | (1990) Epoxy-Resin-Base Bonding Systems for Concrete (AASHTO M235) |
| ASTM D 790 | (1996) Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials |

1.2 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Manufacturer's Data and Instructions; FIO.

The Contractor shall submit the manufacturer's technical data indicating the material properties. The technical data shall include description of surface sealant, equipment, and installation procedures for the epoxy injection work. The manufacturers instructions for use, including preparatory work, injection, and curing shall be submitted.

SD-13 Certificates

Certificates Of Compliance; FIO.

Prior to use of epoxy adhesive, the Contract shall submit a certificate of compliance for each manufacturer's batch of adhesive proposed for use in the contract work stating that the adhesive complies with the contract requirements for the epoxy adhesive. Certificates shall include actual test results of each batch of adhesive proposed.

1.3 CONTRACTOR QUALIFICATIONS

1.7.1 Applicator's Qualifications

Each applicator engaged in the epoxy injection process contract work shall have a minimum of five years of documented experience in successful epoxy

injection repair projects on concrete structural components.

1.7.2 Worker's Qualifications

Each worker engaged in the epoxy injection process contract work shall have satisfactorily completed an instruction program in the methods of restoring concrete structures utilizing the specific epoxy injection process required. The instruction curriculum shall have included theory on the nature and causes of cracking in concrete, methods for permanently repairing damaged structural members, the technical aspects of correct material selection and use, and the operation, maintenance, and troubleshooting of equipment used in the repair work.

1.7.3 Worker's Experience

Each worker engaged in the operation of the injection equipment for the contract work shall have a minimum of three years of experience in the operation of the equipment. Workers shall have participated in a minimum of five documented concrete repair projects.

1.4 DELIVERY AND STORAGE

Epoxy injection materials shall be delivered to the project work site in clearly labeled, unopened containers. Each label shall clearly indicate:

(1) Manufacturer's name and address.
(2) Manufacturer's product name or product number.
(3) Manufacturer's lot number.
(4) Mix ratio.
(5) SPI hazardous material rating and appropriate warnings for handling.

PART 2 PRODUCTS

2.1 Surface Sealant

The surface sealant shall be an epoxy paste with adequate strength and adhesion to confine the injection adhesive in the crack being repaired until the injection adhesive has properly cured. After the injection adhesive has cured, the surface seal shall be removed and disposed. Surface sealant shall be as recommended by the manufacturer of the epoxy adhesive for injection, and shall be suitable for uses under the conditions which the contract work is to be performed.

2.2 Epoxy Injection Material

Epoxy adhesive shall meet the requirements of ASTM C881, Type 1, Grade 1. The appropriate Class shall be used for the temperature conditions during the work. This material is a two-component, 100 percent solids, low viscosity, water insensitive material specially suited to injection for sealing of concrete cracks and joints. The adhesive shall meet or exceed the following properties: flexural strength of 10,000 pounds per square inch in accordance with ASTM D 790 and bond strength of 500 pounds per square inch in accordance with ASTM C 321.

PART 3 EXECUTION

## 3.1 LIMITS

Vertical cracks greater than 0.005 inches in width shall be pressure injected with epoxy. Only those cracks shown on the drawings or as approved by the Contracting Officer will be injected. The location of cracks to be injected will be determined following the demolition of the concrete.

## 3.2 EQUIPMENT

### 3.2.1 Type

Equipment used to meter and mix the two injection adhesive components and inject the mixed adhesive into the cracks shall be a nozzle head mixing and positive displacement type.

### 3.2.2 Discharge pressure

Injection equipment shall have capability of discharging the mixed adhesive at any pre-set pressure up to 300 pounds per square inch and maintaining that pressure. The mixing head of the injection lines shall be attached to a pressure check device. The pressure check device shall consist of two independent valved nozzles capable of controlling flow rate and pressure by opening or closing the valve. There shall be a pressure gage capable of sensing the pressure buildup behind each valve.

### 3.2.3 Volume ratio tolerance

Equipment shall be capable of maintaining the volume ratio for the adhesive prescribed by the adhesive manufacturer within + 5 percent by volume at any discharge pressure up to 300 pounds per square inch. The ratio check device shall consist of two independent valved nozzles capable of controlling flow rate and back pressure by opening or closing the valve to restrict material flow. The equipment shall have a pressure gage capable of sensing the back pressure behind each valve.

## 3.3 PROCEDURE

### 3.3.1 Crack preparation

Prior to sealing surfaces, the concrete surfaces along each crack shall be cleaned of loose matter, dirt, laitance, oil, grease, salt, and other contaminants. The manufacturer's recommendations shall be followed for cleaning each area to receive the epoxy adhesive. The surfaces shall be sealed with manufacturers recommended material to contain the epoxy.

### 3.3.2 Injection

Injection shall not proceed unless the temperature of the concrete to receive the epoxy adhesive is at least 40 F. Openings in the surface seal for the entry ports shall be established along the crack. The distance between the entry ports shall be not less than 6 inches nor greater than 18 inches. Injection of the epoxy adhesive into each crack shall begin at the entry port at the lower end of the crack and proceed in an upward direction. Injection shall continue at the first port until the epoxy adhesive appears at the next adjacent port. The first port shall then be plugged and injection started at the second port until the epoxy adhesive appears at the next port. The entire crack shall be injected in the same sequence.

### 3.3.3 Finishing

Curing of the epoxy adhesive shall be in accordance with the manufacturer's recommendations, except that the ambient temperature shall not be less than 40 F. After the epoxy adhesive has cured, the surface seal and special fittings shall be removed. The surface along the crack shall be ground flush. Indentations and protrusions caused by placement of the entry ports or other causes shall be removed.

## 3.4 TESTING

At all times during the course of the contract work, complete and accurate records shall be kept and made available to the Contracting Officer. The Contractor shall conduct additional tests of the volume ratio and pressure in the Contracting Officer's presence if requested.

### 3.4.1 Pressure Test

The valves on the pressure check device shall be closed and the equipment operated until the gage pressure on each line reads 300 pounds per square inch; the pumps shall then be stopped and the gage pressure shall not drop below 190 pounds per square inch for at least 3 minutes. The pressure check test shall be run for each injection unit at the beginning and at the end of each day that the unit is used in the contract work.

### 3.4.2 Volume Ratio Test

The mixing head of the injection equipment shall be disconnected and the two adhesive components shall be pumped simultaneously through the ratio check device. The discharge pressure shall be adjusted to 300 pounds per square inch for both adhesive components. Both adhesive components shall be simultaneously discharged into separate calibrated containers. The amounts discharged into the calibrated container simultaneously during the same time period shall be compared to determine the mix ratio. The ratio test shall be run for each injection unit at the beginning and at the end of every day that the unit is used in the work.

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